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New Stony Corals (Scleractinia) from Northeastern New Zealand

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Through Dr. A. W. B. Powell, Auckland Institute and Museum, I have been able to study the collection of corals made by him during the 1961 cruise of the New Zealand Marine Department vessel "Ikatere" from the northeastern coast of New Zealand. Between East Cape and North Cape, in depths of less than 100 fathoms there is the richest coral fauna of any portion of the New Zealand shelf when considered either from diversity of kinds, abundance of specimens or frequency of catch. Despite the many trawling expeditions in this region over the years, new species continue to be taken. Although in large part this fauna is peculiar to the region, the current pattern and temperature range would indicate that this portion of the New Zealand shelf is the first to receive immigrants from more northern waters. It is at present impossible to suggest that some of the species represented are new arrivals, but it is to be hoped that as our knowledge of this most important faunal region increases, new arrivals may be detected.

With each new collection our knowledge of the biology of the characteristic coral of this region, *Kionotrochus,* increases. This little turbinoliid genus, not found elsewhere, is now suggested to reproduce at least in part, asexually by transverse fission from a fixed sexually produced parent stock. Although the specimens studied are dry, the evidence of the skeleton is sufficiently strong to indicate that attempts should be made to obtain living material for experimental studies of this very interesting reproductive process.

Given in the following listing are the pertinent station data and the species taken at these stations. One collection taken by H.M.N.Z.S. "Lachlan" off East Cape, housed in the Auckland Museum, is also recorded.

RECORD OF CORALS TAKEN IN 1961 "IKATERE" CRUISE

Station Number	Position	Depth in meters	Date	Species Taken
A 2	Across Tryphena Harbour Great Barrier Island.	24-25	27-4-61	*Culicia rubeola,* 3 fragments, dead and worn.
A—4	Between Tryphena Harbour and Cape Barrier, Great Barrier Island.	44	27-4-61	*Sphenotrochus ralphae,* n. sp. 15 + specimens alive (?)
A—5	Cape Barrier to Rosalie Bay, Great Barrier Island.	55-60	27-4-61	*Flabellum rubrum,* 1 immature, worn.
B—3	Southeast of Poor Knights Islands.	241	28-4-61	*Kionotrochus (Kionotrochus) suteri,* rare.
B—5	Between Mokohinau and Poor Knights Islands.	183	28-4-61	*Kionotrochus (Kionotrochus) suteri,* rare, broken coralla.
B—6	North of Poor Knights Islands	179	28-4-61	*Kionotrochus (Kionotrochus) suteri,* rare.
B—22	Off Whangamumu, 35° 12.2' S., 174° 36.2' E.	183	29-4-61	*Kionotrochus (Kionotrochus) suteri,* fragments.
B—23	Off Cape Brett Island, 35° 09' S., 174° 33' E.	192	29-4-61	*Kionotrochus (Kionotrochus) suteri,* rare; *Letepsammia* sp., fragments.
B—24	Off Cape Brett Island, 35° 07' S., 174° 29.2' E.	188	29-4-61	*Kionotrochus (Kionotrochus) suteri,* abundant.
B—25	Off Entrance to Bay of Islands, 35° 04' S., 174° 26.3' E.	208	29-4-61	*Kionotrochus (Kionotrochus) suteri,* abundant.
B—26	Off Entrance to Bay of Islands, 35° 04' S., 174° 23.2' E.	184	29-4-61	*Kionotrochus (Kionotrochus) suteri,* abundant. *Flabellum aotearoa,* n., sp., two alive. *Letepsammia,* n. sp., fragments.
B—27	Northeast of Cape Brett, 35° 06' S., 174° 21.3' E.	143-146	29 4-61	*Kionotrochus (Kionotrochus) suteri,* abundant; *Flabellum aotearoa,* n. sp., fragments; *Flabellum sp.,* worn fragments; *Letepsammia* n. sp., fragments.
B—41	Northeast Bay of Islands, east of Cavalli Islands, 35° 01.1' S., 174° 13.5' E.	182	2-5-61	*Kionotrochus (Kionotrochus) suteri,* rare.
B—42	East of Cavalli Islands, 34° 59.3' E., 174° 10.2' E.	188	29-4-61	*Kionotrochus (Kionotrochus) suteri,* rare.
B—43	East of Cavalli Islands, 34° 57.1' S., 174° 07.2' E.	218	29-4-61	*Kionotrochus (Kionotrochus) suteri,* rare.
D—28	Bay of Islands, off north headland in Deep Water Cove	60	30-4-61	*Kionotrochus (Kionotrochus) suteri,* common.
D—33	Bay of Islands between Mosquito Point and Moturua Island.	18	1-5-61	*Culicia rubeola,* dead and worn.
Rock	4.5 miles northeast of the Aldermen Islands.	102	5-61	*Ceratotrochus (Ceratotrochus) limatulus,* n. sp., 19 + specimens alive; *Flabellum rubrum,* 1 immature specimen.
H.M. N.Z.S. Lachlan	Off East Cape, 37° 39' E., 178° 34' E.	183+	10-5-61	*Letepsammia,* sp., fragments; *Kionotrochus (Kionotrochus) suteri,* common; *Flabellum* sp., fragments.

Family RHIZANGIIDAE d'Orbigny, 1851

Genus **Culicia** Dana, 1846

Culicia rubeola (Quoy and Gaimard, 1833).

1962. *Culicia rubeola* (Quoy and Gaimard); Ralph and Squires, Zool. Publ. Victoria Univ. no. 29, p. 4, pl. 1, figs. 1-5.

Fragments of this common North Island littoral species occurred in samples from "Ikatere" station D-33 at a depth of 18 m., and at Station A—2 at 24-25 m.

Family MICRABACIIDAE Vaughan, 1905

Genus **Letepsammia** Yabe and Eguchi, 1932

Letepsammia sp.

1958. *Stephanophyllia formosissima* Moseley; Wells, B.A.N.Z. Antarctic Res. Exped. Repts. Ser. B. vol. 6, pt. 11, p. 263.
1962. *Stephanophyllia formosissima* Moseley; Ralph and Squires, Zool. Publ. Victoria Univ. No. 29, p. 16.

In 1958 J. W. Wells recorded a specimen in the British Museum (Natural History) reportedly collected from New Zealand. This record of micrabaciid corals from New Zealand was not substantiated until the "Ikatere" collections were examined and fragments of coralla found at three stations. Additional fragmentary specimens were collected by the "Lachlan" from East Cape. None of the specimens are sufficiently well preserved to warrant illustration or description at present. There is, however, little doubt that they are conspecific or very closely related to the forms described from Australia by Wells (1958). Those and other specimens will be discussed in a forthcoming study of the micrabaciid corals. The erstwhile synonym of *Stephanophyllia, Letepsammia,* is utilised for the species, for *Stephanophyllia* should be restricted in its sense to corals conforming more closely to the type species, S. *elegans*.

The "Ikatere" specimens are small fragments of coralla that appear to have been heavily preyed upon and show much regeneration from earlier damage. Most of them represent one sixth of the corallum, the weak points of the whole structure being the position of septa I.

Distribution: "Ikatere" station B—23, off Cape Brett Island, 192 m. "Ikatere" station B—26, off entrance to Bay of Islands, 184 m. "Ikatere" station B—27 northeast of Cape Brett, 143-146 m. H.M.N.Z.S. "Lachlan," off East Cape, 183+m. Australia.

Family CARYOPHYLLIDAE GRAY, 1847

Subfamily Caryophyllinae Milne Edwards and Haime, 1857

Genus **Ceratotrochus** Milne Edwards and Haime, 1848

Ceratotrochus (Ceratotrochus) limatulus n. sp. Plate 1, Figs. 5-9

Holotype: A specimen from the underside of a large flat rock (85 x 60 x 16 cm.) taken by the New Zealand Government Trawler "Ikatere," 4.5 miles northeast of the Alderman Islands, New Zealand, from a depth of 102 metres. Collected by A. W. B. Powell, April, 1961. Holotype and 9 paratypes deposited in the Auckland Institute and Museum. Nine paratypes from the same locality deposited in the U.S. National Museum.

Description: Coralla are subcylindrical, moderately tall, attached by broad bases to a rock substrate. The wall is thick near the base, made massive by deposits of stereome. The wall is covered by low coarse granules often quite obscure. Costae are not well developed even near the upper margin of the corallum where the granules can be seen to be aligned approximately transversely so as to indicate low broad costae. The edge zone of the polyp is 5 to 10 mm. in length. Below the edge zone the granules become horizontally jointed to form very wavy, irregular and incomplete ridges. Septa are very slightly exsert, less than one mm. Septa I and II are about equal in size, and extend to the edge of the columella; their upper margin is smooth and evenly arched until they fall vertically into the fossa immediately adjacent to the columella. The proximal edges of these septa is sometimes slightly wavy; their lateral faces are ridged parallel to the leading edge and are very finely granular. Septa III are small, thinner, shorter and may be evenly interspersed about the corallum, or missing in some systems. Septa IV are very short and thin. The columella is massive, formed of tightly interlocking pleats, not discrete rods. Measurements of the holotype are:

Height	Maximum Diameter	Number of Septa	Size of Columella
14.7	6.95	48	1.8

Remarks: Several of the specimens show budding which superficially appears to be extratentacular but one specimen clearly indicates that intratentacular budding occures in the species (figs. 5, 6). The linkage between the two corallites is trabecular.

Two subgenera of *Ceratotrochus* are recognised: *Ceratotrochus*, having a corallum with granulated or spinose costae; and *Conotrochus*, having an epithecate corallum (Vaughan and Wells, 1943; Wells, 1956). The present species lacks a definite epitheca, but possesses a wall which superficially suggests an epitheca. It is possible that dead and worn specimens or poorly preserved fossils in which the position of the edge zone could not be determined, and which have a wall similar to the present species have been misinterpreted. It is also possible that the distinction between the two subgenera is not significant; however, at the moment, there is not sufficient comparative material available to assess with confidence the relationships involved.

The new species is closest in skeletal morphology to (*Ceratotrochus*) *hiugaensis* Yabe and Eguchi 1942, from Japan. The wall of this species is nearly smooth, a feature which sets both species apart from other *Ceratotrochus* (*Ceratotrochus*), but the Japanese form is strongly conical and somewhat shorter than the New Zealand species. The difference in form may represent differing modes of life, for there is no stereome present on *C.* (C.) *hiugaensis* which might thicken the basal portion of corallum in the New Zealand specimens.

Wells (1958) discussed *Ceratotrochus* (*Conotrochus*) *typus* from Tasmania, and united seven species under the name. The result is a species having a cosmopolitan distribution through the Tertiary and modern seas. Lacking sufficient material upon which to base an opinion of Well's synonymy, it is accepted for the present time.

The specific name is derived from the Latin word *limatulus* meaning somewhat filed or polished.

Distribution: Known from only the type locality, 4.5 miles northeast of the Aldermen Islands, New Zealand: 102 metres.

Subfamily Turbinoliinae Milne Edwards and Haime, 1857

Genus **Sphenotrochus** Milne-Edwards and Haime, 1848

Sphenotrochus raphae n. sp. Plate 1, Figures 1-4

1939. *Sphenotrochus intermedius* (Münster) Gardiner, Discovery vol. 18, p. 333
1962. *Sphenotrochus* n. sp. B., Ralph and Squires, Zool. Publ. Victoria Univ. no. 29, p. 9 pl. 2 figs. 7, 8.

Holotype: A specimen from Station A—4, New Zealand Government Trawler "Ikatere," between Tryphena Bay and Cape Barrier, Great Barrier Island, New Zealand, from a depth of 44 metres. Collected by A. W. B. Powell, April 27, 1961. Holotype deposited in the Auckland Institute and Museum. Other materials include 14 paratypes from the same locality deposited in the Auckland Museum and in the U.S. National Museum; Four additional specimens from N.Z.O.I. Station C 325.

Description: Corallum small and very compressed so that two large, nearly flat faces are formed which terminate laterally in end costae. The base of the corallum terminates in a sharp, tapering point. The angle formed by the lateral edges of the corallum is about 45°. Costae are well developed, those on the lateral ends of the corallum are complete to the base. Costae I extend to the base, while costae II arise slightly above I. Other costae arise by branching from lower cycle costae except that the branching positions may become obsolete causing the costae to appear as if arising by intercalation. Costae I are slightly swollen basally, thinning where the higher cycles appear. Costae are slightly broader than the interspaces, and are surmounted by one or more rows of low (?) granules. The lateral edges of the costae, which are raised high above the surface, are covered by minute spines. Septa I and II form a single group which are evenly exsert about 1 mm. These septa are terminate proximally and are deeply notched before the columella. Septa III are evenly intercalated about the calice. Septa IV are accelerated in the systems adjacent to the lateral septa I. All septa are smooth on upper edge except proximally where they may bear several coarse granulations. The upper edge is thickened, caused in mature specimens by a concentration of minute granules. Septa III are thin, appearing to arise about the level of the upper edge of the columella. The columella is composed of four to seven stout vertical rods developing from the union of Septa I and II in the centre of the calice.

Measurements of the holotype are as follows:

Height	Maximum Diameter	Minimum Diameter	Septal Number
6.7	4.3	2.7	32

Remarks: Ralph and Squires (1962) discussed the affinities of this species, and further discussion is given in Squires (1961). Gardiner (1939) does not illustrate *S. intermedius* (Münster) and his description is sufficiently vague to permit any number of *Sphenotrochus* to be included therein. The specimens figured by Duncan (1873) as *S. intermedius* are not the same as the present species and appear, as indicated by Gardiner,. to be closely allied to the Atlantic group of *S. auranticus*.

From Duncan's illustrations it would appear possible that more than one species is included in *S. intermedius*. The specimen illustrated on plate 41, figure 3, 4, 5 (Duncan, 1873), has a pointed base, highly exsert septa, and only two columella processes, all of which are characters separating it from the New Zealand species. The specimen illustrated on plate 41, figure 1 and 2 (Duncan, 1873), has a rounded base and coarsely granular septa, neither of which is found in *S. ralphae,* and which appear to separate it from the other specimen.

The species is name for Dr. Patricia M. Ralph, Department of Zoology, Victoria University, Wellington.

Distribution: "Ikatere" station A—4, between Tryphena Harbour and Cape Barrier, Great Barrier Island, 44 m. N.Z.O.I. Station C 325, off Manukau Harbour, 55 m. off Cape Barrier, Great Barrier Island, 55 m. (Ralph and Squires, 1962).

Genus **KIONOTROCHUS** Dennant, 1906

Kionotrochus (Kionotrochus) suteri Dennant, 1906. Plate 2, Figures 10-14

1960. *Kionotrochus* (*Kionotrochus*) suteri Dennant; Squires, Rec. Dom. Mus. vol. 3, pt. 4 pp. 283-288, figures 1-11.

1962. *Kionotrochus* (*Kionotrochus*) *suteri* Dennant; Ralph and Squires, Zool. Publ. Victoria Univ. no. 29, p. 8, pl. 2 figs. 5, 6.

This species has been adequately figured and described in the publications cited in the synonymy and need not be further treated descriptively here. Squires (1960) called attention to the similarity between young *Kionotrochus* and mature *Cylindrophyllia,* relating these two genera as subgenera by suggesting neotenic retention of the union between septa III and II in the latter, and because of the common tympaniform corallum. Materials from the "Ikatere" collection have shown that the similarity may go much further than then suspected.

At stations B—26, B—27, B—28 and the "Lachlan" East Cape Collection, were found short, tympaniform coralla attached to shell fragments. These forms are about the size of *Kionotrochus* and *Cylindrophyllia* (maximum observed diameter 2.5 mm.) and are short (about 1 mm. high) and have the general septal characters including three complete cycles with pali developed before septa II, laterally highly spinose septa, and a minor columella formed by the fusion of septa I. Coralla of smaller individuals are costate, the costae being simply spinose. Larger individuals, however, are epithecate, sometimes quite heavily, but all intermediate grades ranging from almost no epitheca to a heavy one are represented. Those specimens with the heaviest epitheca often have the heaviest, most massive septa as would be expected. The range in size, however, is not within expectable limits, but is smaller than is usual for such morphological variation. Polycyclic bases are common. Deposition of the epitheca is not even, but tends to be in thick bands separated by a region of thin epitheca through which the costae are apparent. As many as three of these bands can be seen in a vertical distance of one millimeter.

Turbinoliid corals completely invest their skeletons, building them both outside and inside. A typical *Kionotrochus* corallum has a flat base when young, but construction of the costae through time covers this

flat base and creates a pointed one with the costae extending to the very tip. The form of the mature corallum is not an indication then, of the habit of the young stages.

The morphological evidence of the cylindrical coralla indicates that they are the bases from which *Kionotrochus* buds because: 1. the septal pattern is identical with that on the base of small, immature *Kionotrochus;* 2. Diameters of the small *Kionotrochus* and the cylindrical coralla closely approximate each other; 3. the banding of the epitheca of the cylindrical stock suggests many episodes of regeneration; 4. There is not the size variation to be expected in a natural population. Transverse fission is not unknown among corals, and indeed is becoming more commonly recognised. Vaughan and Wells (1943) suggest that in addition to the hermatypic genus *Fungia* for which the process is well known, transverse fission occurs in *Flabellum, Placotrochus, Trochocyathus* and *Endopachys.* Rossi (1962) has described a unique transverse fission in a living *Sphenotrochus* from the Mediterranean.

That the process is not a simple parricidal budding in which the mother polyp dies is suggested by the aging of the trophozoid as indicated by increasing thickness of the septa and wall.

Final determination of the mode of budding must await the study of living or preserved materials.

Distribution: Very common along the northeast coast of New Zealand.

Family FLABELLIDAE Bourne, 1905

Genus FLABELLUM Lesson, 1831

Flabellum rubrum (Quoy and Gaimard), 1833.

1962. *Flabellum rubrum* (Quoy and Gaimard); Ralph and Squires, Zool. Publ. Victoria Univ. Wellington: 29, 13, pl. 5 figs. 1-18, pl. 6, figs. 1-9.

In addition to the reference cited above, I have prepared a comprehensive review of this species which is ready for publication by the New Zealand Oceanographic Institute. Only fragments referable to the species are found in the present collection. This is unusual, for *F. rubrum* is widely distributed over the northeast coast of New Zealand, although not generally in the depths from which most of the present collections came. Fragments probably referable to the species were taken on the rock slab described previously, while other fragments even less certainly identifiable were obtained from other stations.

Flabellum aotearoa, n. sp. Plate 2, Figures 15-18.

Holotype: A single specimen collected from Station B—26, New Zealand Government Trawler "Ikatere", off the entrance to the Bay of Islands, northeast of Cape Brett, New Zealand, from a depth of 369 metres. Collected by A. W. B. Powell, April 29, 1961. Holotype deposited in the Auckland Museum.

Other materials include fragments from "Ikatere" Station B—27, and two specimens from the Collections of the New Zealand Oceanographic Institute.

Description: The corallum is compact and ruggedly constructed. The lateral edges of the corallum form an angle in excess of 90° (ranging from 90° to 140°) but even the presence of a large crest on the lateral edges does not extend them to a horizontal position. The calicular margin is neither highly arched nor highly lacerate. Pedicel

short, oval in section, its longer diameter being in the plane of the long axis of the corallum. The wall is smooth and broadly ridged behind septa I and II. Brown to brownish purple bands are present on the walls and are arranged parallel to the upper margin of the wall. Vertical colouration of the wall is greatly reduced, although present behind septa I, II and III. The wall is not epithecate in the usual sense, being composed of fine granules arranged in rows approximating growth lines, but lacking the concentric rugosities of the normal "flabellid" wall. The upper edge of the wall is finely dentate, with lancelets formed by septa of the systems I and II and their adjacent septa V. Each lateral face bears five prominent lancelets, the sixth one being less well developed than the others. Septa are present in four complete cycles with portions of the fifth present in all coralla known. Septa I are the most exsert and the largest, arching outward from the wall to fall nearly vertically into the fossa. The proximal edge of these septa is only slightly thickened at depth in calice, but lateral granulation of the septa increases in density downward. Septa I in the lateral ends of the corallum are joined by the wall several millimetres from this distal end so that the distal portion extends beyond the wall as a crest. Septa of lower cycles are similar to septa I but are small and more lightly constructed. Septa II, III and IV are progressively shorter and appear in sequence. Pitting of the interior of the wall adjacent to the septa is very fine.

Measurements: (in millimetres):

	Height	Maximum Diameter	Minimum Diameter	Angle of Lateral Edges	Pedical Diameter
Holotype	19.6	30.45	17.5	122°	1.9
Paratype	15.2	22.2 (est.)	11.2 (est.)	104°	1.8
N.Z.O.I. C770 ..	11.7	19.0	9.4	114°	1.85
N.Z.O.I. C801 ..	13.5	22.7	13.6	114°	1.8

Remarks: This species belongs to the group of lacerate flabellids of the Indo-Pacific and North Atlantic Oceans. A revision of the Indo-Pacific species of this group is in progress and, as a result, discussion of the species is limited to comparative considerations. The present species is very closely related to an undescribed species widely distributed through the Philippine Islands and differs from it largely in the colouration of the corallum. The latter is a deep purple colour throughout and lacks the banding of *F. aotearoa*. Also, the corallum of *F. aotearoa* is more heavily constructed and the lacerations of the upper edge of its wall are not so pronounced. Both of these species differ from *Flabellum deludens* von Marenzeller and *Flabellum japonicum* Moseley. The first of these has a more highly lacerate upper calicular margin than *F. aotearoa,* while the latter is much rounder in calicular profile.

Two fossil species referable to this group have been described from New Zealand. Squires (1958) referred to *Flabellum deludens* and later (1962) described *Flabellum planus* from the Miocene of Kaipara. Neither of these species has any apparent ancestral relationship to *F. aotearoa,* suggesting that it is a post-Miocene (probably Holocene) immigrant. The first mentioned is a highly lacerate form with a very jagged calicular margin. The latter conforms more in form but has an extremely heavy wall which is present in all known specimens.

The specific name is the Maori word meaning "long white cloud," the name for New Zealand.

Distribution: "Ikatere" B 26—Off entrance to Bay of Islands; 369 m.
"Ikatere" Station B 27—Northeast of Cape Brett; 143-146 m.
N.Z.O.I. Station C 801—East of Coromandel Peninsula; 130 m.
N.Z.O.I. Station C 770—Bay of Plenty; 130 m.

ACKNOWLEDGEMENTS

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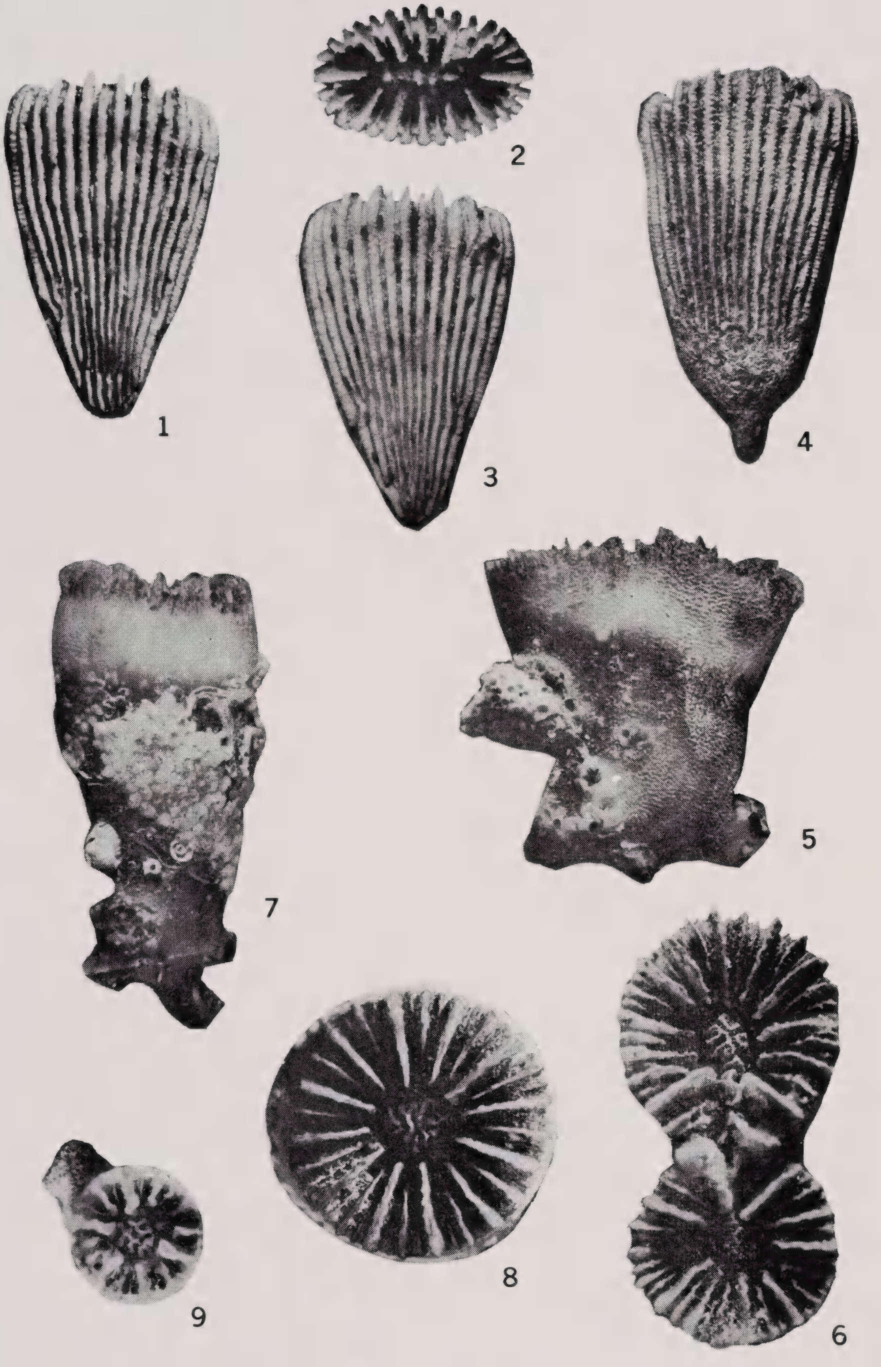
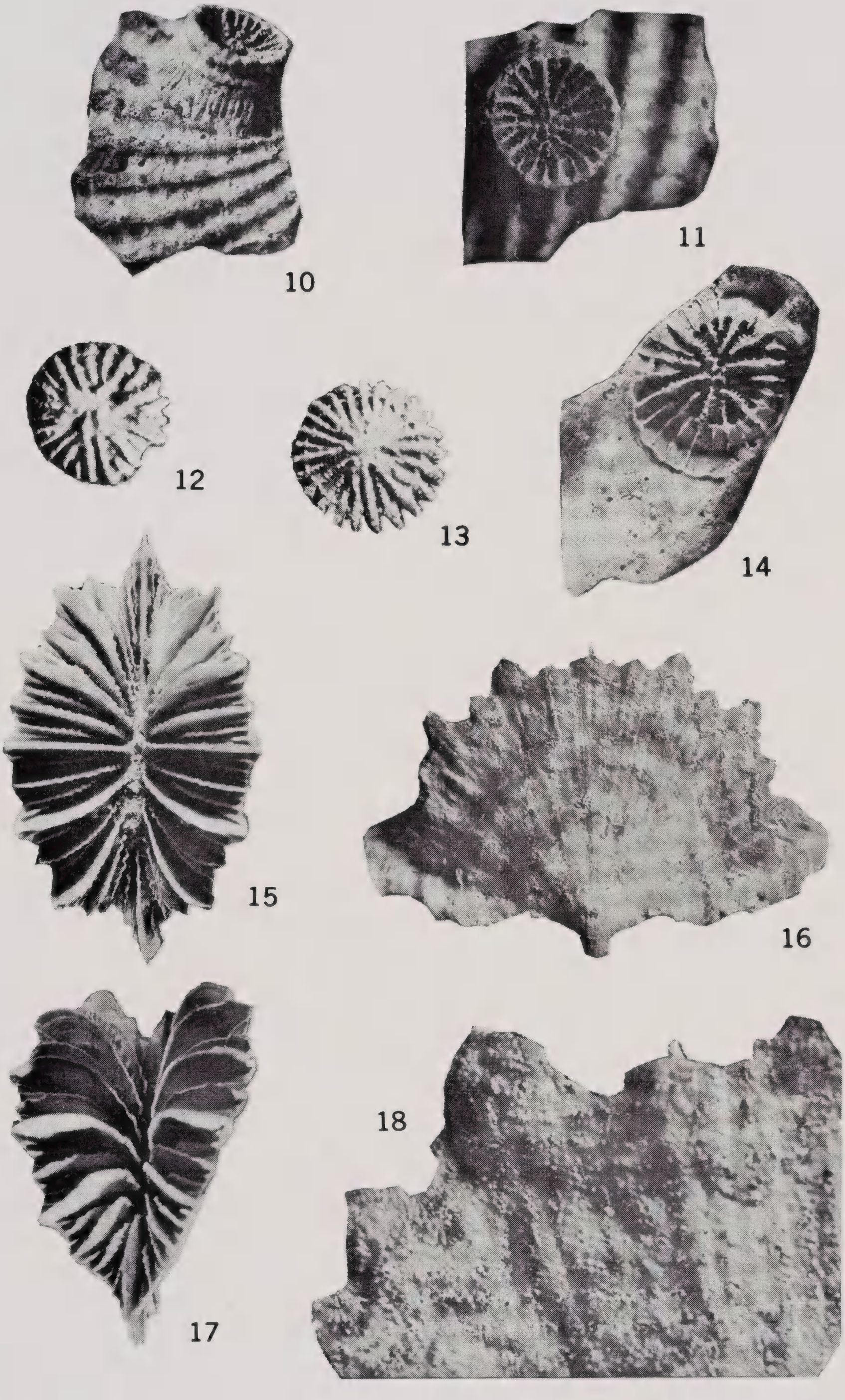
PLATE 1



Figures 1-4. *Sphenotrochus ralphae*, n. sp. (Figs. 1-3) Holotype, "Ikatere" Stn. B—26, X 7.0 (Fig. 4) N.Z. Oceanographic Institute Stn. C325, X 6.6.

Figures 5-9. *Ceratotrochus* (*Ceratotrochus*) *limatulus*, n. sp. (Figs. 5, 6), Paratype "Ikatere" rock specimen, X 5.5. (Figs. 7, 8) Holotype, "Ikatere" rock specimen, X 5.5. (Fig. 9) Paratype, "Ikatere" Rock specimen, X 5.5.



Figures 10-14 *Kionotrochus* (*Kionotrochus*) *suteri*. Figs. 10, 11). Trophozoid (?), "Lachlan" East Cape collection, X 5.85. (Fig. 14) *ibid*, X 6.5. (Figs. 12, 13) base of young specimen, "Ikatere" Stn. B—26, X 9.0. (Fig. 14) Trophozoid (?). "Lachlan" East Cape collection, X 6.5.

Figures 15-18 *Flabellum aotearoa*, n. sp. Holotype, "Ikatere" Stn. B—26. (Figs. 15-17) X 2.0. (Fig. 18) X 10.0.

New Zealand Molluscan Systematics with Descriptions of New Species: Part 4

By A. W. B. POWELL, Auckland Museum

ABSTRACT

In this part two new species of New Zealand mollusca are described, *Maurea turnerarum* and *Exomilopsis hipkinsi,* the latter as type of a new genus. Two other species, *Limulatys reliquus* Iredale, 1936 and *Xenophalium (Xenogalea) thomsoni* (Brazier, 1875) make new records for the New Zealand fauna. Still another record of an exotic species, *Tenpetasus liberatus* (Pease, 1868), requires confirmation before admittance as a true member of the fauna. The remainder of the paper deals with other New Zealand records of exotic species, most without legitimate claim for inclusion in the New Zealand fauna and finally two items concerning rectifications of nomenclature.

Family TROCHIDAE

Subfamily CALLIOSTOMATINAE

Genus MAUREA Oliver, 1926.

Type (o.d.) : *Trochus tigris* Martyn, 1784 = Gmelin, 1791

Maurea turnerarum n. sp. **Plate 3, Figures 1-3.**

This shell recalls *waikanae* Oliver, 1926, of the *cunninghami* series but is at once distinguished by its thin fragile shell, the outlines of the last two whorls, which are strongly convex as opposed to the lightly convex outlines of the earlier spire whorls, the very sharply and narrowly rib-keeled periphery, overall granulation of the primary spirals and the brown dot and dash pattern, which although confined to the crisp narrow gemmate spirals, resolves into an arrangement of radiate series both dorsally and on the base. In *waikanae,* in addition to the dot-dash markings on the spirals there are regular but diffused maculations both subsuturally and at the periphery.

Post-nuclear whorls about eight, rather straight-sided to the penultimate, after which the body-whorl accelerates and becomes more convex in outline both above and below a sharp peripheral carina. The spire angle of the upper whorls is about 80° but for the whole spire, almost 95°. The aperture is rhomboidal and capacious. Post-nuclear sculpture of crisp, narrow, finely gemmulate cords and threads. Three primary cords on the first four post-nuclear whorls but thence increasing to five in addition to the peripheral carina. Interstitial spirals vary between one and three over the penultimate and eight to nine on the body-whorl, but only one in each interspace is gemmulate. Base densely sculptured with crisp narrow cords and threads, most of which are gemmulate. There is no great difference in strength between the primary and the secondary cords but the tertiary spirals are plain, weak, and irregularly disposed threads. There are about 28 gemmulate cords on the base and 13 of these are considered primary, for they carry the colour pattern. Spire about one and one sixth height of aperture. Umbilical area closed by a thick white callus. Ground colour light brownish buff above

and near white below, speckled with a dot and dash reddish-brown pattern confined to the primary cords. No diffused maculations, as in *waikanae*. The operculum is horny, smooth, thin and highly polished, the coiling ill defined by a smooth low narrow spiral, not lamellate as in *cunninghami*.

Height 42.0 mm.; diameter 56.5 mm. (holotype).

Locality: Off Mayor Island, Bay of Plenty, 200 fathoms.

Holotype presented to the Auckland Museum by Misses Ann and Elizabeth Turner.

Family CAPULIDAE

Genus TENPETASUS Iredale, 1929.

Type (o.d.) : *Capulus liberatus* Pease, 1868.

Tenpetasus liberatus (Pease, 1868).

1868—*Capulus liberatus* Pease, Amer. Journ. Conch., vol. 3, p. 284, pl. 24, f.2.
1915—*Capulus intortus* Lamarck, Hedley, Journ. Roy. Soc. W.A., 1, p. 189 (not of Lamarck).
1929—*Tenpetasus liberatus* Pease, Iredale, Mem. Queensl. Mus., vol. 9, 3, p 277.

In August, 1960, Mr C. H. Robinson of Kerikeri collected seven examples of the above species from a sandy beach at the western end of Moturoa Island, Bay of Islands.

These shells were not found alive but they are in good state of preservation; the largest is 10 mm. x 14 mm. The species has a wide Indo-Pacific distribution, but is most commonly found at Norfolk Island. Hedley (l.c.) recorded it under the name of *Capulus intortus* Lamarck, from Funafuti, Loyalty Islands, New Hebrides, Norfolk Island and Geraldton, Western Australia. I have series from Isle of Pines, New Caledonia and Mauritius.

Iredale (l.c.) restricted *intortus* Lamarck to its type locality, "West Indies," and there is a generic name for it in Krebsia Mörch, 1877. Iredale considered that the Indo-Pacific shells were neither conspecific nor congeneric with *Krebsia* and proposed for them the generic name *Tenpetasus,* the nucleus of which is Rissoid-like, not a smooth helicoid as in *Capulus.*

This New Zealand record is possibly the result of a chance spat fall, so further evidence is desirable before considering the species a component of the New Zealand fauna.

Family NATICIDAE

Genus CONUBER Finlay and Marwick, 1937.

Type (o.d.) : *Natica conica* Lamarck, 1822.

Conuber conica (Lamarck, 1822).

1822. *Natica conica* Lamarck, Anim. sans vert., 6 (2), p. 198.
1952. *Conuber conica* (Lamarck), Powell, Rec. Auck. Inst. Mus., 4 (3), p. 174.

At the above reference the writer recorded the finding by Mrs I. Worthy, of two half-grown but well preserved examples of this common south eastern Australian naticoid at Tauranga Bay, Whangaroa. Two further examples, also in a good state of preservation, but likewise small, 12-13 mm. in height, were taken at Takou Bay, Northland, by Mr. C. H. Robinson.

By its scarcity and the fact that no adult examples have been taken in New Zealand waters suggests that the species, upon this evidence, cannot be considered a true member of the New Zealand fauna. Such rare occurences are probably the result of odd successful spat-falls, but it would seem that owing to adverse physical factors these migrants neither reach maturity nor do they breed here.

Anderson (1960. Journ. Malac. Soc. Aust., 4, p. 24) pointed out that of three species of Northern Hemisphere Naticoids, *nitida, pallida* and *catena,* the first mentioned hatches as a planktotrophic veliger but the other two emerge from the egg at the crawling stage. Life histories of Austro-Neozelanic naticoids are unknown but it would seem that both planktonic and sedentary types are represented, the former probably by *Conuber, Notocochlis* and *Mammilla* and the latter by *Tanea* and *Uberella.*

Genus **XENOPHALIUM** Iredale, 1927

Type (o.d.) : *Xenophalium hedleyi* Iredale, 1927.

Subgenus **XENOGALEA** Iredale, 1927.

Type (o.d.) : *Cassis pyrum* Lamarck, 1822.

Xenophalium (Xenogalea) thomsoni (Brazier, 1875). Plate 3, figures 4, 5.

1875. *Cassis (Casmaria) thomsoni* Brazier, Proc. Linn. Soc. N.S.W., 1, p. 8.
1927. *Xenophalium (Xenogalea) thomsoni* (Brazier), Iredale, Rec. Aust. Mus. 15, No. 5, p. 342, pl. 31 (not 32), figs. 6, 7.

Type locality—New South Wales, on sandy bottom, 45 fathoms five miles due east of Sydney Heads.

Remarks—This species, which is generally distributed along the continental shelf of New South Wales, can now be considered an established constituant of the New Zealand fauna, for five fresh or live-taken specimens are now known from the shelf of the North Auckland east coast in from 20 to 40 fathoms.

The species resembles *pyrum* but is at once distinguished by the strongly carinate periphery, followed by a weaker carination below it, at about the level of the top of the aperture. Both keels are crenulated by numerous closely spaced nodules, more elongated and weaker on the second keel. A third subobsolete spiral row of closely spaced weak elongate axials is often present at about the middle of the body-whorl.

The shoulder area and the space between the peripheral keel and the one below it, are both deeply concave. The shoulder area also bears two or three primary smooth spiral cords and a varying number of weak interstitial threads. The coloration is very constant, consisting of spiral rows of small rectangular reddish-brown maculations on a light pinkish fawn ground. Uppermost row of maculations on the periphery, other two on the base.

Records (New Zealand), trawled off Cuvier Island, Bay of Plenty, in about 40 fathoms (Misses Ann and Elizabeth Turner); trawled 30 miles north of Mangonui; off Stephenson Island, Whangaroa, 20-39 fathoms, in crayfish pots (Mrs. I. Worthy); Great Barrier Island, from crayfish pots; Marsden Point, Whangarei Heads, beach specimen (K. Hipkins).

Measurements (mm.)—

Height	Width	
49.0	34.0	New South Wales (holotype).
54.5	48.5	New South Wales, Ulladulla, 40-50 fathoms.
73.0	51.0	New South Wales, 60-80 fathoms, Twofold Bay.
75.0	53.0	New Zealand, 30 miles north of Mangonui.
78.0	51.0	New South Wales, 60-80 fathoms, Twofold Bay.

Family CYMATIIDAE

Genus CHARONIA Gistel and Bromme, 1847.

Type (monotypy) : *Murex tritonis* Linnaeus, 1758.

Charonia tritonis (Linnaeus, 1758).

1758. *Murex tritonis* Linnaeus, Syst. Nat., ed. 10, p. 754.
1913. *Septa tritonis* (Linnaeus), Suter, Manual of the N.Z. Mollusca, p. 304.

Suter (1913, l.c.) included this species in the New Zealand fauna with two locality references "Cape Maria van Diemen (Dr. Dieffenbach) ; Ahipara Bay, thrown up after gales", but specimens substantiating these claims are apparently not available.

Smith (1915, Brit. Antarctic "Terra Nova" Exped., 1910, Zool. 2, No. 4, pt. 1, Moll., p. 84) recorded "a young specimen of a Triton in perfect condition, allied to the early stage of the well-known *C. tritonis* (Linn.)", from near the North Cape, 11-20 fathoms. Smith remarked that the specimen did not represent the young of *C. rubicunda* (Perry), another large Triton occurring in New Zealand.

This record, based with reservation, by Smith, upon a juvenile of only 11.5 mm. can be ignored, especially since I was unable to locate the specimen in the British Museum collections.

However I can now record the authentic finding of a near adult sized example of *tritonis* in a fairly fresh condition from Wainui Bay, Bay of Islands County, Northland. This was obtained by Mr C. H. Robinson of Kerikeri from a Maori boy who had just picked it up on the beach.

There is still no evidence that the species actually lives in New Zealand waters and the possibility that the Wainui shell was a dropped specimen cannot be ruled out.

Genus MAMMILLA Schumacher, 1817.

Mammilla simiae (Deshayes, 1838).

Type (monotypy) : *M. fasciata* Schumacher, 1817 = *Albula mammata* Röding, 1798.

1838. *Natica simiae* Deshayes, Hist. Nat. Anim. sans Vert., 8, p. 652.
1934. *Polinices simiae* (Deshayes), Powell, Trans. Roy. Soc. N.Z., vol. 64, p. 156.

This species, which is common in East Australian and Kermadec Island waters was first recorded for New Zealand on the basis of four beach worn shells from the beaches at Cape Maria van Diemen.

Although this species has not as yet been taken alive in New Zealand waters to my knowledge, further records of freshly dead shells from a number of northern localities indicates the species as an estab-

lished entity in our fauna. These records are:—Taupeka Point, Bay of Islands (K. Hipkins), Takou Bay, Northland (C. H. Robinson), Goat Island Beach, Leigh (K. Hipkins), Oruawharo, Great Barrier Island (Mrs. G. Mitchener) and Waihau Bay, Bay of Plenty (Mrs. K. P. Walker).

Family TONNIDAE

Tonna maculata (Lamarck, 1822).

1822. *Dolium maculatum* Lamarck, Anim. sans. Vert., 7, p. 260.
1848. *Dolium maculatum* Lamarck, Reeve, Conch. Iconica, 1, pl. 3, f.4.
1885. *Dolium costatum* maculatum Lamarck, Tryon, Man. of Conch., 7, p. 264, pl. 4, f.21.
1937. *Dolium maculatum* Lamarck (partim.), Bayer, Zool, Meded., 20, p. 43,
1952. *Tonna dolium* (Linnaeus) (non Linnaeus, 1758), Tinker, Pacific Sea Shells, Honolulu, figs. facing p. 136.
1952. *Tonna dolium* (Linnaeus) (non Linnaeus, 1758), Powell, Rec. Auck. Inst. Mus., 4 (3), p. 177, pl. 35, f.5.
1954. *Tonna tessellata* (Lamarck), Kira, Coloured Illustrations of the Shells of Japan, pl. 22, f.9.

In 1952, at the above reference I recorded this tropical Indo-Pacific shell from New Zealand waters under the erroneous determination of *dolium* Linnaeus, 1758. The correct name for this shell is still subject to some doubt but the figures quoted in the above synonymy will at least fix the New Zealand records to the exact species concerned. In particular I compare the New Zealand shells to Reeve's *"maculatum"* and Tinker's *"dolium"*. I follow Bayer, 1937 in separating *dolium* Linnaeus, 1758, with synonyms *Buccinum tessellatum* Bory St. Vincent and *Dolium fimbriatum* Sowerby, 1820, from *maculatum* Lamarck, 1822, based upon Martini-Chemnitz, Syst. Conch. Cab., 3, pl. 117, f.1073.

If this nomenclatural interpretation is correct then *dolium* is the rather small shell (50-60 mm. in height) which develops in its adult state a stout laciniated labial varix, and *maculata* is a similar but much larger shell (80-135 mm. in height) which always lacks the thickened labial varix.

Further records of *maculata* are now known from New Zealand waters—two in fresh condition from south of Parengarenga Harbour (Mrs. J. B. Johnston), one trawled in the Bay of Plenty, and another, evidently taken alive from a trawler operating off Manukau Heads (Mr. G. W. Barker).

Genus **CHICOREUS** Montfort, 1810.

Chicoreus ramosus (Linnaeus, 1758).

1758. *Murex ramosus* Linnaeus, Syst. Nat., ed. 10, p. 747.
1908. *Murex ramosus* Linnaeus, Moss, Beautiful Shells of N.Z., p. 16.
1924. *Murex ramosus* Linnaeus, Bucknill, Sea Shells of New Zealand, p. 66.

This well known Indo-Pacific mollusc was first recorded for New Zealand waters by E. G. B. Moss (1908, l.c.) on the basis of two specimens, one said to have been taken alive, from Tauranga Harbour. Dr. C. E. R. Bucknill (1924, l.c.), who verified the specimens, then in the possession of the finder, Mrs. T. M. Humphreys of Tauranga, stated that they were found in the Waikareao Estuary to the west of Tauranga.

It is of interest that two authentic New Zealand records can now be added:—Takou Bay, east coast, Northland, one adult, somewhat bleached but in good condition, collected by Mr. C. H. Robinson, ca. 1936. Same locality; small but very fresh specimen collected by Mrs. I. Worthy ca. 1920.

Despite the above three records there is no evidence that the species actually breeds in local waters.

Family COLUMBELLIDAE

Genus EXOMILOPSIS new genus

Type : *Mangelia spica* Hedley, 1907.

The shell described below is undoubtedly congeneric with, and in fact very close, specifically, to *Mangelia spica* Hedley, 1907, type from 80 fathoms off Narrabeen, New South Wales, and subsequently recorded by the same author (1922, Rec. Aust. Mus., 13, 6, p. 335) from 100 fathoms off Cape Pillar, Tasmania, and 110 fathoms off Beachport, South Australia.

Hedley (1922, l.c.) included this species with seven others—*Mangilia anxia* Hedley, 1909, *Mangilia cancellata* Beddome, 1882, *Terebra dyscritos* Verco, 1906, *Donovania fenestrata* Tate and May, 1900, *Mangelia lutraria* Hedley, 1907, *Drillia pentagonalis* Verco, 1896 and *Drillia telescopialis* Verco, 1896—in a new genus, *Exomilus* Hedley, 1918; type (o.d.) : *Mangelia lutraria* Hedley, 1907 (Journ. Roy. Soc. N.S.W., 51, p. M79).

This group of species occurs in the temperate waters of the continental shelf of Australia, ranging from New South Wales to Tasmania and South Australia. There is a superficial similarity in all these species in that they are small, cylindrical, attenuate and rather angulate shells, with a narrow rectangular aperture, but as Laseron, 1954 (The New South Wales Turridae, pp. 48, 49) has already pointed out—"It will probably be found when the whole of the southern Australian species at present included in *Exomilus* are examined together that several distinct groups are represented."

The type of *Exomilus, lutraria* (Hedley), has a moderately deep subsutural sinus as a rounded excavation in the labial varix and the protoconch is of three whorls, the tip blunt and concave, the third cylindrical and narrower than the second whorl.

In *spica* the anal sinus is not present and the protoconch is narrowly conical to cylindrical of $2\frac{1}{2}$ whorls, with a small rounded tip, smooth except for very faint axial threads. The present writer (Powell, 1944, Rec. Auck. Inst. Mus., 3, 1, p. 62) disassociated *spica* from the *Turridae* and suggested its inclusion along with *Etrema trophonalis* Chapman and Crespin, 1928 and *Aesopus semicostatus* Tenison-Woods, 1880 in the Columbellid genus *Retizafra*. To this group also, belong the above mentioned *dyscritos* (Verco) and *fenestrata* (Tate and May). The remaining species may at present be retained in the Turrid genus *Exomilus*.

The new genus *Exomilopsis* is characterised by its strong superficial resemblance to the Turrid genus *Exomilus*, i.e. attenuate spire, sagged, low keeled whorls, crossed by axial folds, and a narrow rectangular aperture, but without an anal sinus.

The genus *Retizafra*, to which *spica* and its allies have most in common, has a fewer whorled more broadly conic protoconch and the shell is of more conventional fusiform shape, the sculpture being axial reticulated by spiral cords.

Exomilopsis hipkinsi n. sp. Plate 3, figure 7.

Shell small, white, attenuated, with tall spire, twice height of aperture plus canal. Whorls 5, plus a tall narrowly conic to pupoid protoconch of 2½-3 whorls, tip small, globose, slightly asymmetric; succeeding whorls tall with lightly convex outlines and terminated abruptly with a vertical slightly variced lip; smooth and glossy but showing faint axial threads over the last whorl. Post-nuclear whorls loosely coiled, sculptured with distinct to prominent spiral cords, those from the middle of each whorl downward, rendered regularly gemmate by otherwise weak axials. In detail, the spire whorls are sculptured above with three narrowly rounded spiral cords with interspaces of slightly greater width. The middle of each whorl is weakly angulated by the uppermost of three stronger and regularly gemmate spiral cords. On the body-whorl, the lowest of the three gemmate cords, which is just emergent at the lower suture, becomes the most prominent and forms a peripheral flange, below which the base is deeply excavated. The base is occupied mostly by a disproportionately large and flexuous pillar which is sculptured with 14 crisp narrow cords, widely spaced above but more crowded towards the tip of the canal. The aperture is narrowly quadrate and terminates below in a short broadly open canal. Outer lip with a vertical profile and no vestige of an anal sinus, but variced within, bearing four tubercles. Just below the lowest tubercle the outer lip is strongly angulate at the termination of the lowest carina. The whole surface of the shell, except for the cords, is densely and delicately striated.

Height 9.75 mm.; width 2.8 mm.

Locality—Cape Maria van Dieman, between the island and the mainland in 3-4 fathoms.

Holotype and one juvenile paratype presented to the Auckland Museum by Mr. K. Hipkins.

The New South Wales *spica* is closely related to the above new species. It differs in having only two spirals above the carina and only 6-7 on the base. Also the axials are much stronger and render all the spire whorls gemmate to some extent.

Family ATYIDAE

Genus LIMULATYS Iredale, 1936.

Type (o.d.) : *L. reliquus* Iredale, 1936 = *Tepidatys* Iredale, 1936;

Type (o.d.) : *T. tremens* Iredale, 1936.

This genus is now added to the New Zealand Recent fauna by the finding of a fresh specimen of the New South Wales *reliquus* in a dredging off Whangaroa, Northland. A New Zealand Tertiary member of this genus is *Atys* (*Aliculastrum*) *lacrimula* Laws, 1939 from Pakaurangi Point, Kaipara (Altonian, Miocene).

Another New Zealand Tertiary species, *Atys improcerus* Marwick, 1931 from the Ihungia Series (Miocene), of Gisborne is more happily

placed in *Pyrunculus* Pilsbry, 1895 (nom. nov.) for *Sao* Adams, 1854 non Billberg, 1820 (Crustacea), non Barrande, 1846 (Trilobita).

Apart from the two New South Wales species, *reliquus* and *tremens* Iredale, the following Japanese Recent species were referred to *Limulatys* by Habe, 1952 (Illust. Cat. Japanese Shells, No. 20, p 138) —*angustatus* (Gould, 1859), *constrictus* Habe, 1952, *muscarius* (Gould, 1859), *okamotoi* Habe, 1952, *ooformis* Habe, 1952 and *scrobiculatus* A. Adams, 1862.

The genus and species are diagnosed by Iredale as follows—"Shell small, shining, thin, elongate oval, not pinched apically, no apical umbilicus, but umbilical fissure at opposite end. Coloration white, with milky spiral lines, but otherwise smooth. The apical depression is not perforate, the outer lip longer than the body of the shell, joining the apical hollow with a downward twist. Columella a little sinuate, thin, but umbilical chink clearly shown. Outer lip thin, aperture narrow, a little broadened anteriorly."

Limulatys reliquus Iredale, 1936. Plate 3, figure 6.

1936. *Limulatys reliquus* Iredale, Rec. Aust. Mus., 19, 5, p. 328, pl. 24, f.20.

Localities—Australia, Sydney Harbour, dredgings (holotype). New Zealand, 2 miles east of Stephenson Island, Whangaroa, 16-17 fathoms, fine grey sand with shell (K. Hipkins and A. W. B. Powell, Oct. 22nd., 1960).

Height	Width	
7.0 mm.	4.00 mm.	(holotype)
5.7 mm.	3.0 mm.	(Stephenson Island)

Holotype in Australian Museum, Sydney.

Family HYDATINIDAE

Genus HYDATINA Schumacher, 1817.

Type (monotypy) : *Bulla physis* Linnaeus, 1758

Hydatina physis (Linnaeus, 1758).

1758. *Bulla physis* Linnaeus, Syst. Nat., ed. 10, p. 727.
1924 *Hydatina physis* (Linnaeus), Powell, N.Z. Journ. Sci. Tech., 6 (5, 6), p. 284.

In 1924 I recorded the first known New Zealand occurrence of this wide ranging Indo-Pacific mollusc, based upon a specimen in the collection of Mr. C. Osborne, who found it some years previously, alive, at Shoal Bay, Tryphena, Great Barrier Island.

At long and irregular intervals the species has ben subsequently collected at a number of Northland east coast localities. These records are Takou Bay (about 25 adult specimens; Mr C. H. Robinson), Port Fitzroy, Great Barrier Island (5 adult specimens, largest 51 mm.; Mrs. Mabey) and Whangaroa Harbour, on mud flats near the wharf, 29th May, 1961 (Mr. R. D. Murray). In addition to the above, colonies have been reported within recent years from both Parengarenga and Houhora Harbours.

It is doubtful if the species breeds in New Zealand waters. The probable pattern is of a series of successful spat falls from time to time. The individuals apparently reach maturity and then the small colony disappears from the area.

Following are measurments of the five largest examples taken at Takau Bay:—

Height	Diameter
57.0	46.0
55.0	45.0
51.0	44.0
49.0	42.5
33.5	27.0

Genus **NAUTILUS** Linnaeus, 1758.

Nautilus pompilius Linnaeus, 1758.

1758. *Nautilus pompilius* Linnaeus, Syst. Nat., ed. 10, p. 709.

Empty shells of *Nautilus macromphalus* Sowerby, 1849, usually in a battered state, are by no means uncommon on Northland beaches, especially Spirit Bay and the Tokerau Beach, Doubtless Bay.

A second species, the common Indo-Pacific *pompilius* Linnaeus, 1758, can now be recorded on the basis of a fairly complete shell from Matakana Island, Bay of Plenty, collected about 1935 by Mr C. H. Robinson, and now in the Auckland Museum.

The two species are readily distinguishable in that the umbilicus is widely open in *macromphalus* but closed by callus in *pompilius*.

These two records have no faunistic significance since the chambered shell renders them permanently buoyant, but the New Zealand occurrences do indicate ocean current trends. The species *macromphalus* is the common one at New Caledonia and since that island group is situated in the vicinity of the source of the East Australian Current then the Northland occurrences are clearly derived through that agency. On the other hand the Bay of Plenty *pompilius* record indicates a source from a different South Pacific location.

Family **ARGONAUTIDAE**

Genus **ARGONAUTA** Linnaeus, 1758

Argonauta nodosa Solander, 1786.

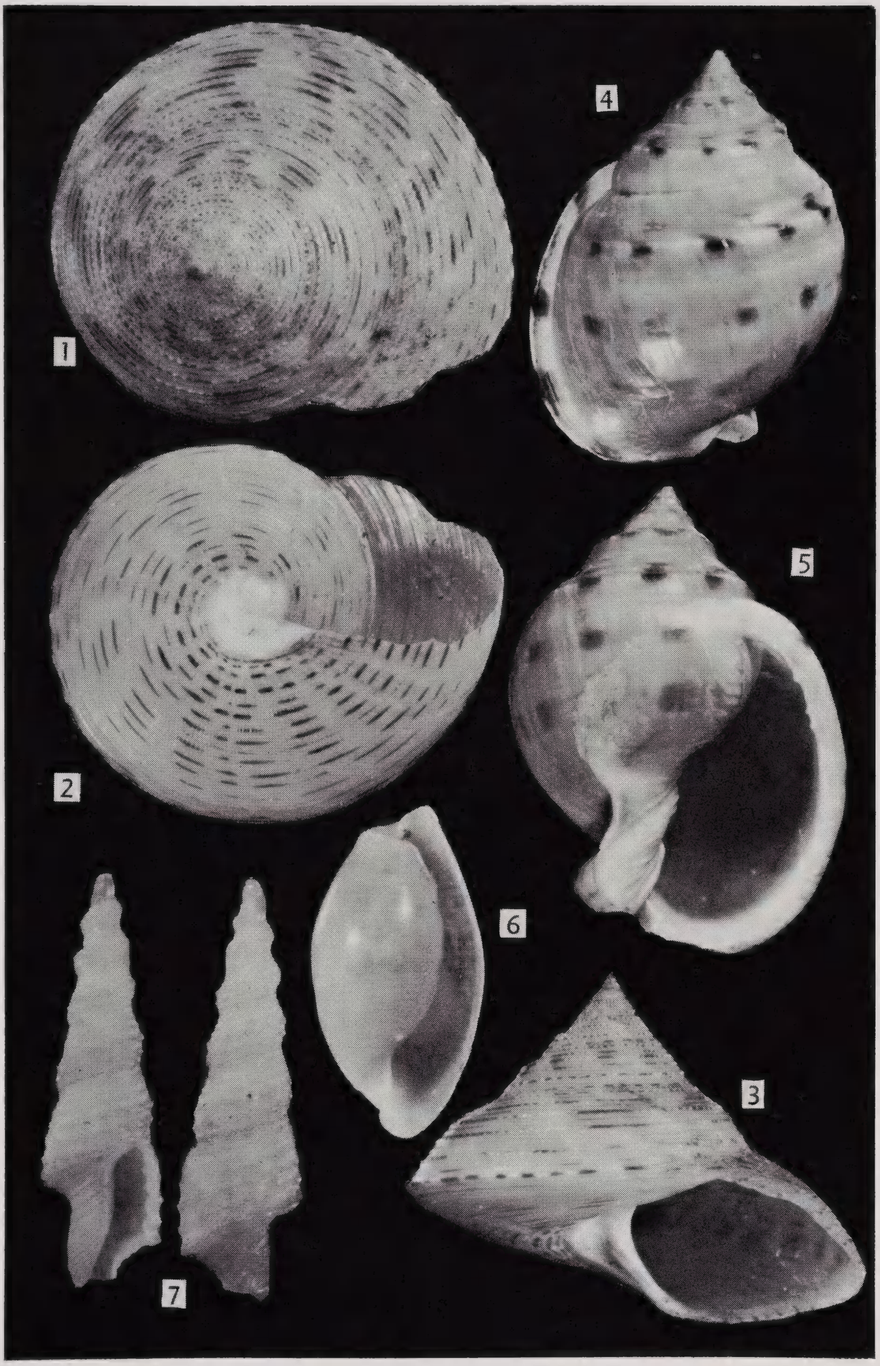
1786. *Argonauta nodosa* Solander, Cat. Portland Mus., p. 96.
1791. *Argonauta tuberculata* Shaw, The Naturalist's Miscellany, vol. 3, p. 995.
1885. *Argonauta gracilis* Kirk, Trans. N.Z. Inst., 17, p. 58, pl. 13.
1933. *Argonauta nodosa* Solander and *tuberculata* Shaw, Powell, Rec. Auck. Inst. Mus., vol. 1, p. 207.
1952. *Argonauta nodosa* Solander, Dell, Domin. Mus. Bull., No. 16, pp. 53-67.

The "eared" and "non eared" forms in the tuberculate Argonauts have long been the subject of discussion (see Powell, 1933, l.c.), whether or not that there are two species, one with ears throughout growth and with coarse tubercles, the other without ears but with fine tubercles.

Dell (1952, l.c.) put up a good case for assuming that only one variable species is represented, for in a large series of specimens, the above suggested distinctions did not hold. In Dell's own words "Some eared juveniles do develop into eared adults. Many more grow into straight-sided adults. Most of the adults with well-marked ears have strong tuberculations, but intermediates exist." Dell further pointed out

that the shell of an Argonaut is the product of one of the most variable parts of that animal, namely the dorsal arms.

A very large Argonaut from Pouto, Kaipara Heads, recently acquired by the Auckland Museum, serves to endorse Dell's argument in favour of one variable species, for this particular specimen is asymmetric in that it has a well marked ear on one side but is non eared one the other side. The shell measures 253 mm. (10 1/8 inches) in length and the "ear" projects 14 mm. from the arcuate sweep of the lip, the condition exhibited on the other side of the aperture.



Figs. 1-3. *Maurea turnerarum* n. sp. 40.0 x 56.5 m. (holotype).

Figs. 4, 5. *Xenophalium* (*Xenogalea*) *thomsoni* (Brazier, 1875), of Cuvier Island, 40 fathoms, Bay of Plenty.

Fig. 6. Limulatys reliquus Iredale, 1936, 5.7 x 3.0 mm., Stephenson Island, 16-17 fathoms, Whangaroa.

Fig. 7. *Exomilopsis hipkinsi* n. sp. 9.75 x 2.8 mm. (holotype).

A Note on Archaeological Work at Ponui Island

by V. F. FISHER, Auckland Museum.

From a knowledge of Ponui Island extending over many years Motunau Bay at the southern end was selected as a likely area for archaeological investigation. The reasons for this selection were, firstly, that it contained the only large area of flat land, and, secondly, the largest stream on the island flowed through the flat. In addition there was evidence that headlands in the vicinity had been fortified and the large bay with extensive mudflats offered good possibilities for shell fish and flounder. Further out a deep channel provided a well known fishing ground for larger fish, of which snapper and kingfish were commonly caught.

Having obtained permission from the owner, Mr. F. Chamberlin, Dr. Robert Bell, of the Department of Anthropology, University of Oklahoma, United States, his wife, Mrs. Virginia Bell and the writer commenced to excavate a small area of the bay in February, 1956.

One or two test pits were first dug some distance apart. Following this preliminary investigation, it was decided to commence work close to the fence, near the mouth of the stream, on the western side of the bay. Each square excavated was five by five feet and this was followed throughout the operation. This first visit lasted over a period of three weeks.

In 1957 and again in 1959 assisted by a small team of students from Ardmore Teachers' College under Mr. A. H. McNaughton, Mrs. McNaughton and Mr. H. J. Whitwell, work was continued for two periods both lasting one week. Dr. Bell and Mrs Bell had in the meantime returned home to Oklahoma. On all three visits the area excavated was continuous and a total of forty-six squares was excavated.

All the material, together with notes, plus information on the early history of the island, was handed over to Miss M. Nicholls, who first wrote a preliminary report published in Volume 6 of the New Zealand Archaeological Association's Newsletter, and then after further study produced the final report.

In conclusion acknowledgements must be made to many persons who helped and assisted.

First to Mr. F. Chamberlin, who not only granted permission to excavate, but who with his wife and family gave much willing help in a variety of ways; to Dr. R. E. Bell for much expert advice and assistance. May I also express appreciation of the work of Mr. and Mrs. A. H. McNaughton, and Mr. H. J. Whitwell, lecturers at Ardmore Teachers' College, and the teams of students under their care, who all worked with interest and enthusiasm. Finally a very special word of thanks to Miss M. Nicholls for her study of the material, and all the hard work that led to the production of the report which follows my brief statement.

Excavations on Ponui Island

By M. P. NICHOLLS, Auckland

Introduction and Setting.

This report analyses further results from a series of excavations carried out at site N 43/1 on the south coast of Ponui Island in the years 1956, 1957 and 1959, described in the preceeding section by Mr. V. F. Fisher. A preliminary report is already available (Nicholls 1963) and may be consulted for other details and additional drawings of artefacts. Ponui Island which lies in the Hauraki Gulf just south of Wai-

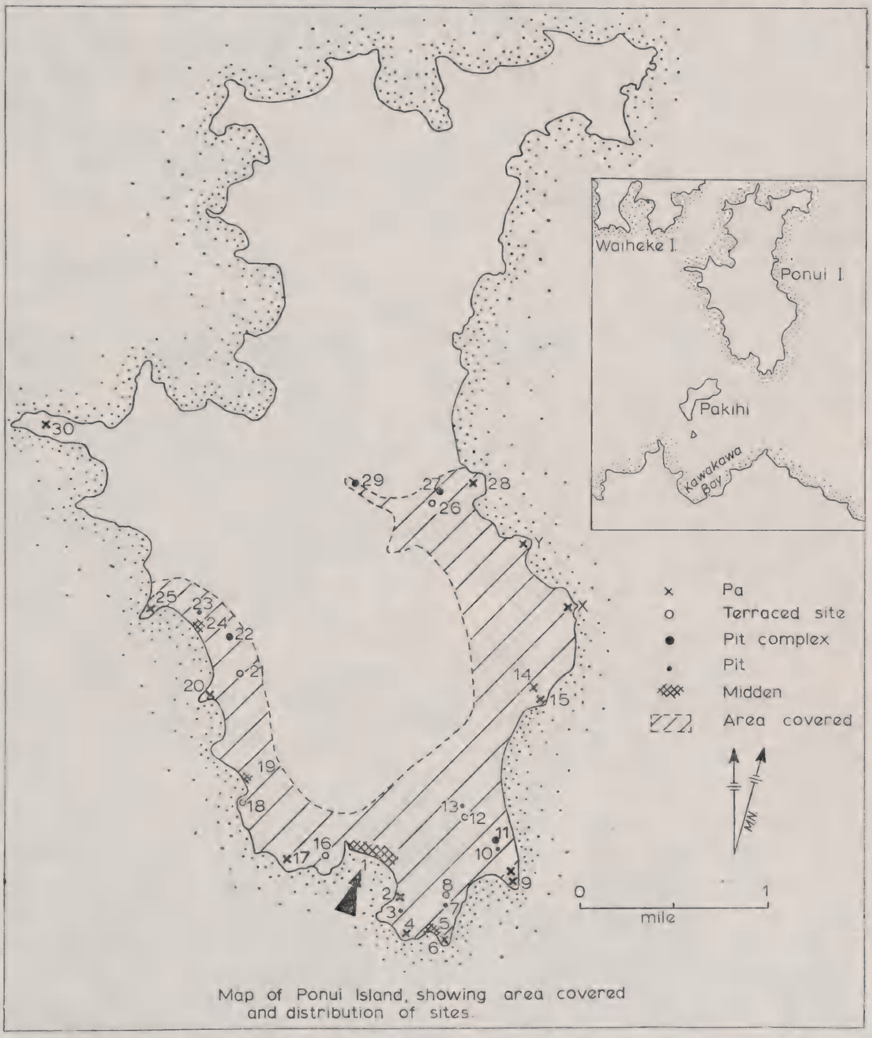


Fig. 1—Map of Ponui Island showing location of N 43/1 in relation to other recorded sites in the area covered by survey.

heke Island (Fig. 1), covers an area of about nine square miles. In the main it is fairly hilly so that the site of these excavations is one of the few areas of flat land available on the island. The site, itself, is situated near the tidal estuary of a stream which flows out on the western side of the bay. The eroding banks of the stream have from time to time cut through a number of *haangi* and other signs of occupation. To the east of site N 43/1 is an old creek bed, beside which is a large midden, comprised mainly of *Chione stutchburyi* and *Amphidesma australe*. Further middens are evident in many places on this area of flat land, but their relationship to site N 43/1 is not known.

At low tide extensive mudflats are uncovered off the bay, and cockles (*Chione stutchburyi*) pipi (*Amphidesma australe*) and the Auckland rock oyster (*Saxostrea glomerata*) are today found here in large quantities. Snapper, *kahawai,* flounder, dogfish, piper, stingrays and herrings are reported to be numerous in the waters surrounding the island. (Trower n.d.).

There is evidence of heavy settlement on the island, with *pa*-sites on many of the headlands. The results of a partial survey of these sites, published by Davidson (1963), are indicated in the accompanying map.

Historic Details.

Graham (1943 p. 64) gives the original name of Ponui Island as "Te Pou-nui-o-Peretu."

On the 16th June, 1853, two Maori chiefs, Karamu and Kupenga, sold their rights on Ponui to the New Zealand Government for £100. On the 4th January of the following year, Ngatai and Hori Pokai, chiefs of the Ngaati Hua and Ngaati Paoa, sold their interests for the sum of £25, and further agreed to take all their pigs from the island, and give up cultivation and dispose of their potato crop. While the archaeological evidence discussed below is suggestive of these events, it is not known historically whether any of this cultivation took place on the bay where the present site is located. Mr. Fred Chamberlin, grandson of one of the Chamberlin brothers who purchased the island in 1854, states that as far as he is aware, no buildings or other structures ever stood on the site, and that since the land was originally put into pasture it has been ploughed several times. However, he also states that the island was the scene of intensive operations on the part of the gum diggers some time last century, and these operations could easily have involved the area of the site.

The Excavations.

Digging by Bell and Fisher commenced in February, 1956, with two test excavations, 5 ft. square (fig. 2). They were later extended into the area which appeared to be the more promising from the results of the test square. The general location of the site was determined from indications of refuse in the eroded bank of the stream nearby. This area was laid out on a five foot grid, without baulks, and each square excavated in a series of six inch levels. The material recovered was bagged according to square and level. In two succeeding years, Fisher returned to the site, accompanied by a group of students from the Ardmore Teacher's Training College. During these two years a record was kept of the position of most artefacts in relation to the grid, and their depth from the surface, but the system of six inch levels was not retained.

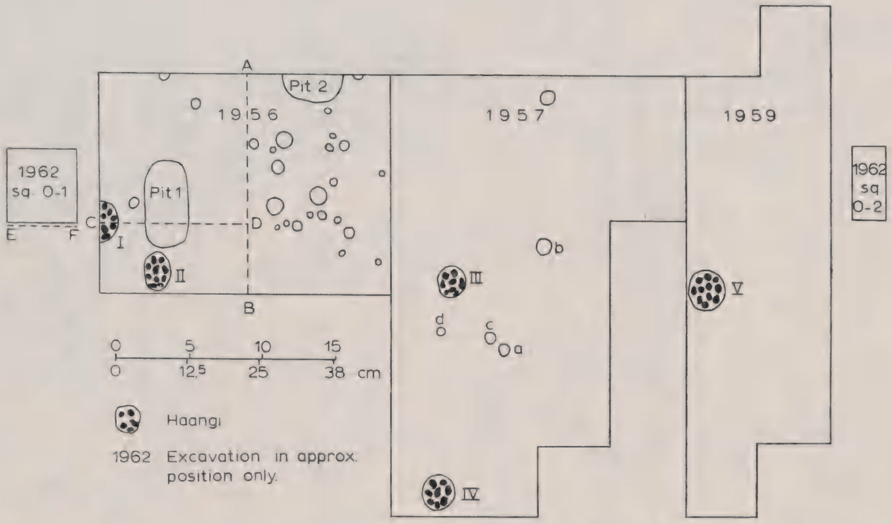


Fig. 2—Map of principal excavations in 1956, 1957, 1959 and 1962 showing distribution of recorded features.

Non-artefactual material was kept separate according to square only. There is, therefore, no indication as to what level or layer this latter material comes from, and consequently for the purpose of this report, reference to all material apart from the artefacts and identified bone is to material recovered in 1956 only. Also, in the absence of records as to the layer of origin of the material much of the following analysis has had to be statistical. To a limited extent this has been checked by a small excavation carried out on a weekend towards the end of 1962.

In order to examine the statistical significance of the distribution of this material, the chi-square test was employed wherever a sufficient quantity of any one type of material was recovered. The results of these tests (shown under the chi-square column of Table I) indicate that the distribution of most materials is not random. It has therefore been inferred that the apparent association between a material and the level where it occurs most frequently is significant.

The first season's excavations revealed a cultural deposit some 18 inches in depth. On the surface lay a dark humus and turf zone designed as layer I. Underneath this was a thick zone of gravel and sand containing some shell called layer II, and under this again lay a thinner dark organic layer, also containing shell. This lowest layer, III, rested conformably on the undisturbed sub-soil (fig. 3), and was of a limited extent, fading out toward the west, but continuous over the rest of the site. Pit I, and haangi I and II and possibly haangi IV as well, were apparently cut from the top of layer III (fig. 3), as probably were some of the postholes. The location in the stratigraphy of the other structural features is not known. However a posthole (fig. 2), containing the remains of timber, suggests that some may not have been very old. This posthole was also ringed with stones. It is not clear whether or not these features, which appeared mainly during the 1956 excavations, were the only ones indicative of structures. The soil composition of both layers II and III was sandy and gravelly, with a fairly

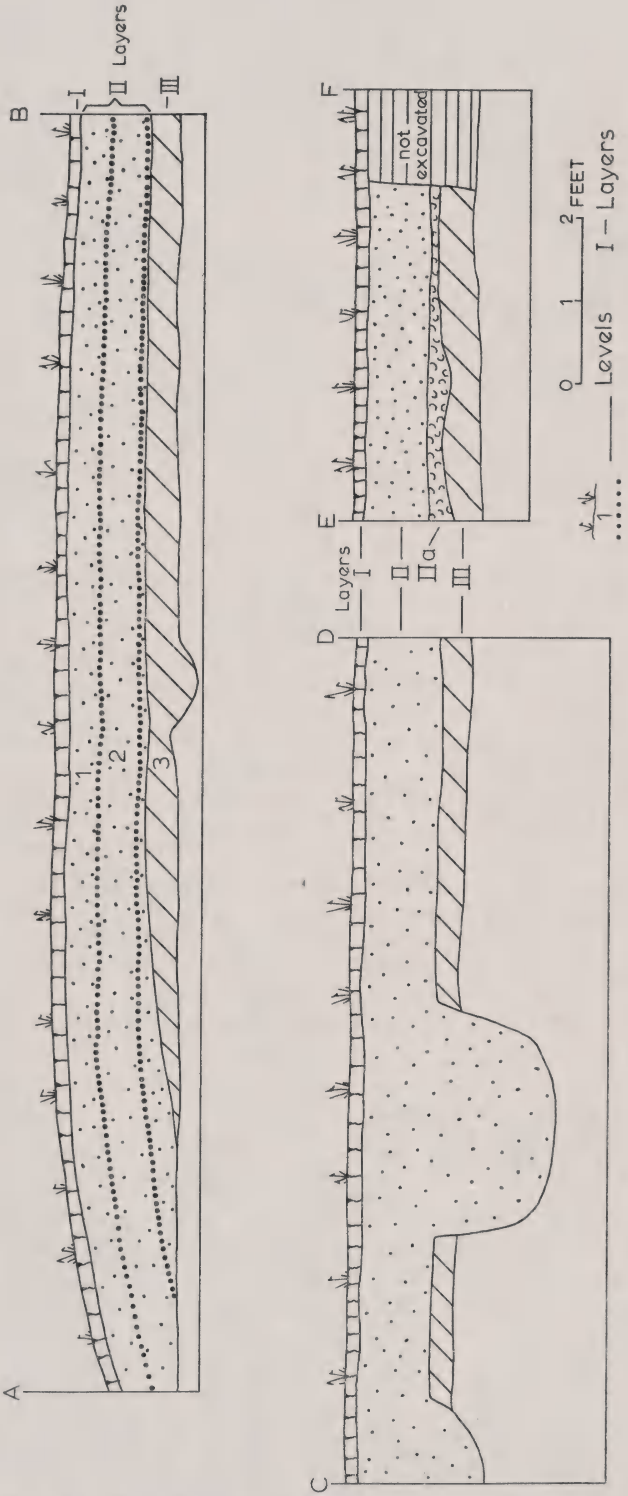


Fig. 3—Stratigraphic cross-sections showing layers at three selected points across excavated areas. In section A-B the levels are superimposed on the layers.

high charcoal content. Layer III seems to have been rather more dark and greasy. The artefacts appear to have been scattered through both layers in a random fashion, and there is no evidence of occupation floors. In fact, the very homogeneous mixture of soil, sand, charcoal, shell fragments, bone and artefacts suggests that there has been much disturbance since the artefacts were first discarded. During the excavations carried out in 1962 a thin, discontinuous and almost sterile layer of beach gravel and broken shell was found between layers II and III (fig. 3).

As the section drawings show the top of layer III is approximately 12 inches from the surface, and thus roughly coincides with the third six-inch level from which material was collected in the excavations. Thus, one may expect that material from levels I and II will come from layer II, and that material from level III may be identified with layer III. However, this can be an approximation only as layer III fluctuates somewhat in depth and intrusions may be expected where pits and post-holes have been dug from the top of layer III.

After the material recovered had been sorted according to level, the percentage of that material occuring in each level has been recorded in Table I. It will be seeen that while stone artefacts appear in all levels, by far the greatest percentage falls in level I, apart from the chert flakes, which appear to be more numerous in level II. On the other hand almost the entire amount of fish bone comes from level III as does most of the porous whale or seal bone. The dog bone and bird bone shows a slightly different distribution, coming in almost equal quantities from levels II and III, with only a slight amount from level I. Mr. R. J. Scarlett, who identified some fragments of bone as *Dinornis*, states that although some of this bone is subfossil, other pieces appear to have been broken while fresh. Other bird bone includes albatross, shag, *weka*, pigeon, *tui* and duck, whose distribution by level is indicated in Table II. A number of pieces of pig bone have also been tentatively identified, and these pieces occur predominantly in level I, with a few fragments in level II. This distribution coincides with that for other European contact materials: china, copper nails, and clay pipes, approximately 80 per cent of which occur in level I, with the remainder in level II.

Although it is not possible to draw too many conclusions from this analysis, it does seem that a general picture emerges, in which bone material occurred predominantly in the bottom layer of the site, with stone material becoming more frequent on the upper layers. The distribution of stone flakes, roughouts, and adze flakes coincides to a certain extent with that of the European material, but in all cases there is not the high concentration of material in level I that occurs with the European material, and the stone artefacts occur at depths beyond those reached by the pipes and china. This seems to suggest that the occupation that was responsible for the stone flakes and other stone material was not identical with that which provided the European contact material despite a roughly similar distribution.

Obsidian flakes show a change in material from predominantly green to approximately an equal distribution of green and grey types when held to transmitted light, as one moves from the lower to the higher levels. This agrees with Green's (Green and Shawcross 1962) suggestion of a change from green (Mayor Island) obsidian, to other sources of

obsidian, in the cultural sequence for the Auckland Province. Samples of the obsidian have been subjected to the dating techniques described by Ambrose and Green (1962). Unfortunately the surfaces of many of the obsidian flakes have been badly scratched at some stage, which made accurate readings for all pieces or surfaces impossible, and it has therefore not been possible to differentiate between the layers or levels on this basis. In general, however, hydration rims with a minimum thickness comparable to those of level IV at Skipper's Ridge (N 40/7) or period 2 of the Kauri Point pa (N 53-54/5) are to be observed, while some surfaces give earlier readings equal to layer B of the Opito site (N 40/3) or level III and fill of level I features at Skipper's Ridge.

The following shells have been identified:

Pecten novaezelandiae (queen scallop), *Lunella smaragda* (cats eye). *Glycymeris laticostata* (dog mussel) *Mytilus canaliculus* (common mussel). *Cookia sulcata* (Cook's turban) *Amphidesma australe* (pipi) *Chione stutchburyi* (tuangi) and *Cabestana spengleri* (Spengler's trumpet).

All this shell was very worn, and each species is represented by only one or two examples, apart from the samples taken during the 1962 excavations.

The samples collected from the 1962 excavations and analysed by J. M. Davidson proved to contain scattered and fragmentary shell. Some appears to be water worn, but other pieces are midden refuse. The amount of shell per sample never amounted to more than approximately 6 per cent of the total, and it was not possible to find significant differences between layers in types of shellfish utilised.

Other materials recovered from the limited 1962 excavation tended to confirm the conclusions already arrived at on the basis of distribution. Thus layer II in Square 0-1 produced bottle glass, a drill point, and adze flake, and five obsidian flakes (4 grey and 1 green). Bone identified from this layer included pig, spotted shag, and the Polynesian dog. Layer IIa, underlying layer II, yielded an adze flake and some fragmentry bone that could not be identified. From layer III, four flakes of obsidian (1 grey and 3 green pieces), two pieces of stone files and a fish hook fragment were obtained. Identified bone includes the grey duck, spotted shag (?) paradise duck, Polynesian dog, seal bone and fish bone.

Another test in Square 0-12 at the other limit of earlier excavations yielded a moa tibia-tarsus, a human tooth, and the bones of dog, seal and spotted shag. There was also a ring bead cut from bird bone. Unfortunately the stratigraphy of this square did not tie in with that of Square 0-1, as was hoped, and so did not clarify completely the stratigraphy in the 1959 excavation (see fig. 3). The main cultural deposit seemed to be similar in composition to layer II, in Square 0-1, but rested directly on the natural subsoil. The failure to find evidence of layer III, or the black layer reported by Mr. Fisher in earlier excavations. may be explained by the fact that the exact position and alignment of the earlier excavations was hard to identify, and the Square 0-12 may not have been in the exact position shown in fig. 2.

ARTEFACTS

For convenience description of artefacts has been subdivided according to materials in which they were manufactured. The description covers the artefacts recovered in the excavations of all three sea-

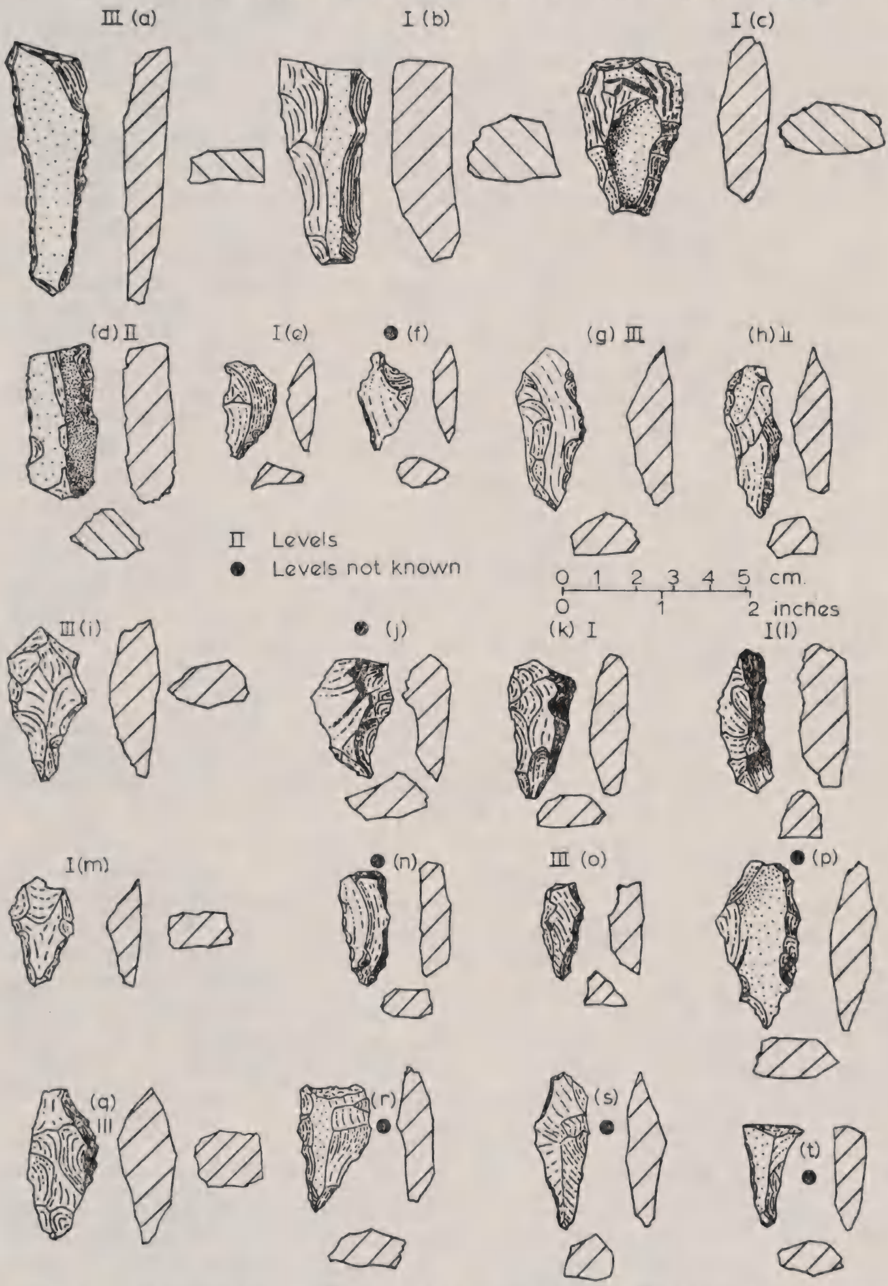


Fig. 4—A representative selection of flaked points (drills) with the levels from which they were recovered indicated. Points a-d are in basalt the remainder in chert-like material.

sons, and where possible the level and location of artefacts is given in the illustrations.

Stone Flaked Points.

This site is notable for the number of flaked points that were recovered. These are commonly called drill points, although as Lockerbie (1953 p. 28) has noted "not all specimens so classifed were used for the purpose of drilling." Of the 61 flaked points found six were made from a basaltic stone and the rest from various types of chert-like material. Considering the number of points in these materials it is surprising that only one core and a few waste flakes of similar materials were found. Small numbers of the flakes show signs of use along one edge.

The 'drillpoints' were in all cases made from flakes, which have been retouched along two edges, converging to a point. For descriptive purposes they fall into two broad categories, based on the process employed in retouching and I am grateful to F. W. Shawcross for pointing out this method of description. There are 35 drillpoints retouched on both edges from the ventral surface, while 26 are retouched on one edge from the ventral, and on the other edge from the dorsal surface. This results in two somewhat distinctive cross-sections, although they do not provide watertight categories. The first technique tends to result in a cross-section with a flattened dorsal and ventral surface and steep sides, the dorsal surface being slightly wider than the ventral surface. The second technique results in a more complete modification of both surfaces, giving a diamond-shaped cross-section. (Fig. 4). Most of the 'drillpoints' are 20 to 46 mm. in length, and 8 to 25 mm. in breadth, although some of the points in basalt are larger. It is probable that among the shorter drillpoints some have been broken. The widest point is usually from half to two-thirds of the way along the artefact from the point. Of the 55 points that were probably not broken, 28 had their widest point in this area, 15 had their widest point at the end opposite the point, four had no place that could really be designated as the widest. The remaining eight either had their greatest width near the point, or more than two-thirds of the way toward it.

In fig. 4 points a-d are made of basalt and exhibit secondary working from the ventral surface only. The remaining points illustrated are in chert-like material. Among them points j and p-t possess a cross-section typical of those with secondary working from both sides, while points g-i and k-o, show the working from one side only. Point j is an example of a type, of which there are two or three in this collection, where the shaft is distinctly curved, in a manner that seems to preclude its being hafted in the manner suggested by Buck (1950, p. 194). Flaked points that seemed not to have been drills are illustrated in e and f. These chert tools have been retouched partway along the sides and have pointed tips at both ends.

Adzes and Roughouts.

Of the adzes and roughouts recovered only one, a broken roughout from level III, shows pretensions of ever having been more than about four inches in length (Fig. 5, e). This broken roughout is much thicker in cross-section than the others that were found, and is the only one that bears any sign of hammer dressing. Although very crude in form, its shape has more affinities with the hog-back or type 4 adze than with

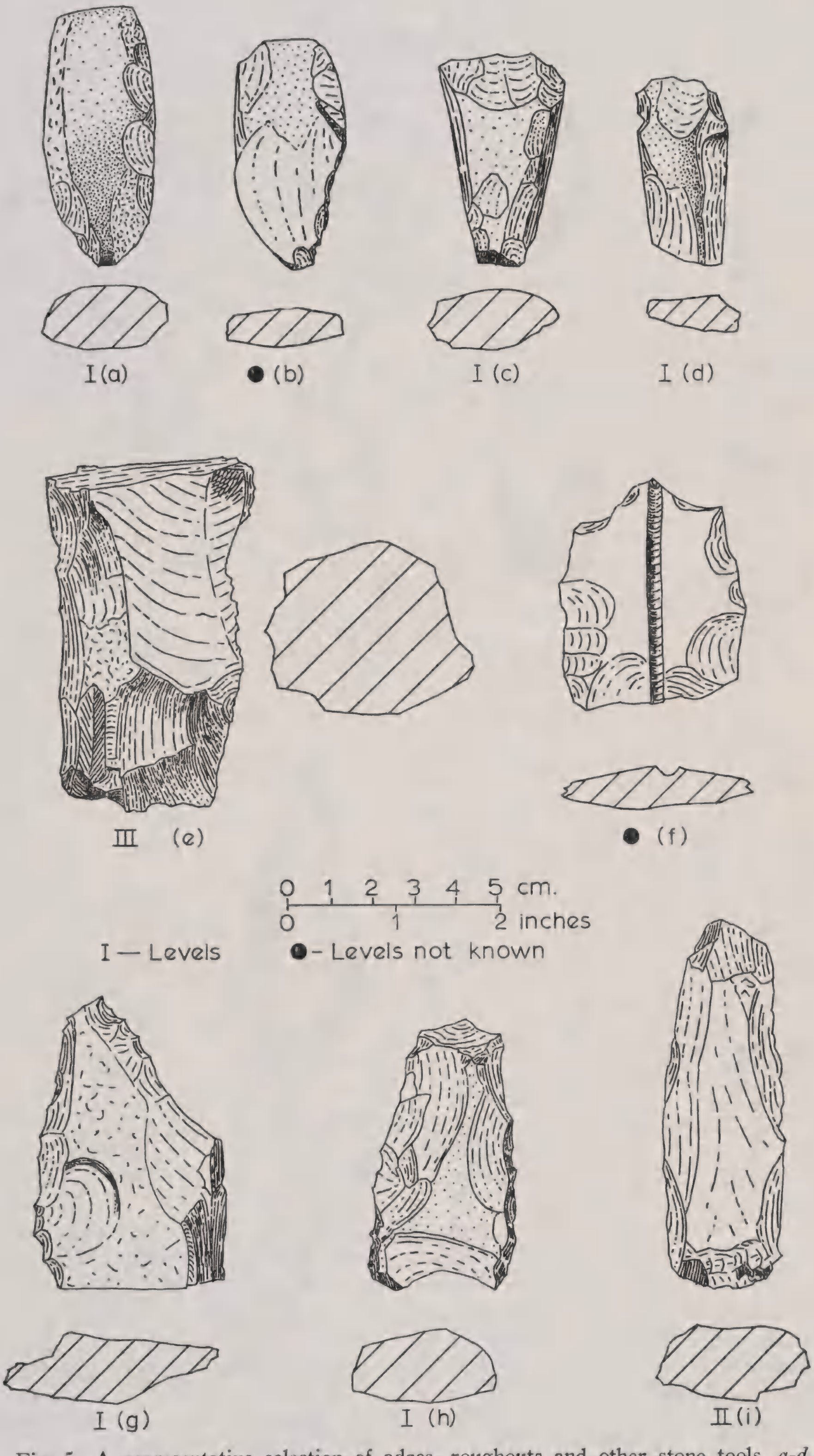


Fig. 5—A representative selection of adzes, roughouts and other stone tools. *a-d* and *h* are small flake adzes with some polishing, *i* is a roughout for same type of adze, *e* is a hammer dressed portion of a larger adze. *f* is a grooved stone, possibly for filling, g is a worked basaltic flake.

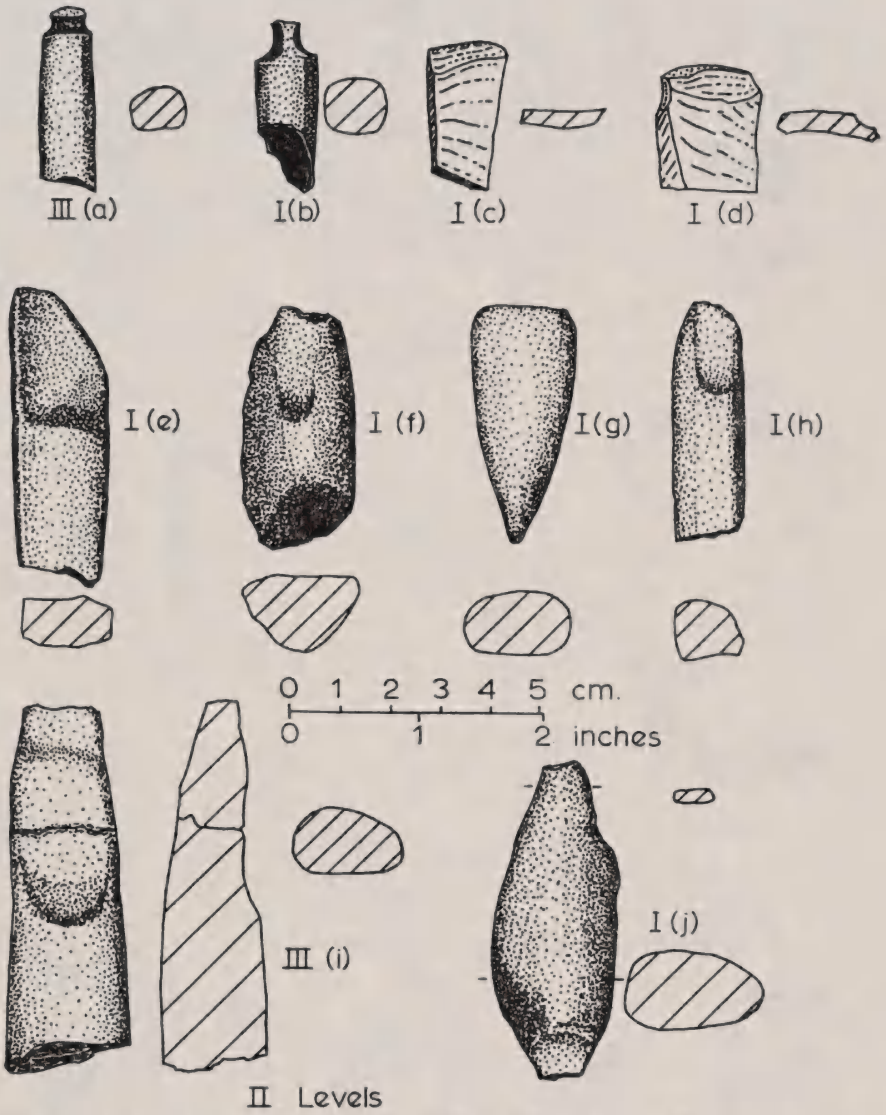


Fig. 6—Other stone artifacts: *a* and *b* are portions of stone fish lure shanks, *c* and *d* are two very small flake adzes with polish only on bevels, *e-j* are a representative selection of sand stone files.

any other. A smaller roughout in a much lighter coloured stone also has a shape like a hog-back or similar triangular type 4 adze. This roughout exhibits no sign of hammer dressing or polishing however.

The majority of the adzes are small, seldom polished and, if polished, only to a slight degree (Fig. 5, a-d, h). One probably has been reshaped from a larger polished adze with a 2B cross-section, but the reformed blade shows no sign of use (Fig. 5, c). All the others have certain of the following characteristics in common: they appear to have been formed from flakes, in cross-section they are irregular, and thin,

but tending towards a rectangular or plano-convex cross-section (Davidson 1961, p. 9), none are of a size greater than 10 cm. in length, and none show signs of hammer dressing. Two of them are little more than 3 cm. in length (Fig. 6, c-d). Most of them show traces of polishing on raised areas, and all along the bevel of the blade, while on some, slight traces of polishing also appear along the sides, again to smooth off protruberances. The impression one gains is that these

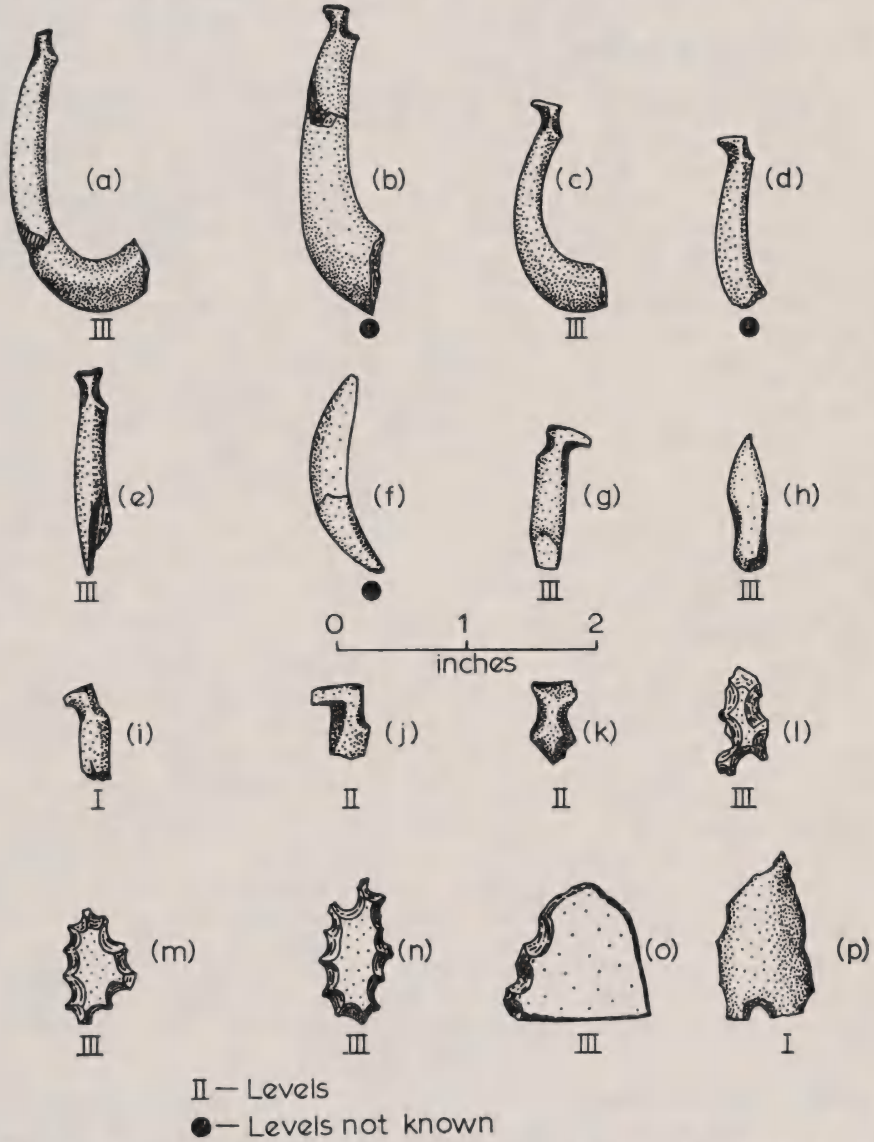


Fig. 7—Bone items largely fishing gear; *a-c* are broken one-piece fishhooks, *f* is a worked dog tooth, *h* is a dog tooth fashioned into a point for a composite hook, *g* and *i-k* are heads from one-piece hooks, *l-n* are cores from the manufacture of one-piece hooks, *o* is a blank with a sharp blade edge, *p* is a deliberately pointed bone.

are completed tools and that they maintain some consistency in their pattern of manufacture. This impression is strengthened by the existence of five stone flakes shaped to the form and proportions of these adzes, which could not have served as roughouts for the better made and formally recognised adze types (Fig. 5, i).

A number of flakes from adzes were found, both polished and hammer-dressed, but none is large enough to permit even a tentative identification of type adze to which it belongs.

Other Stone Artefacts.

(a) A number of basaltic flakes in irregular shapes show signs of use along one or more edges. In some cases this is merely a series of chippings on a fairly sharp edge, but one or two show a very steep flaking along one fairly thick edge (Fig. 5, g).
(b) A piece of stone (shown in fig. 5, f) has a groove formed on a thin flake of crumbly rock, which seems unsuitable for adze-manufacture. The surface of the stone in the vicinity of the groove is also polished and scratched, but no signs of working appear on the other side. It is possible that it was used for filing purposes.
(c) Stone files. A number of files, all of them broken, were recovered, along with a piece of similar stone in the process of being divided. All the files were made of the same sort of material—a very rough, porous sandstone. They cover a wide range of shapes, of which a representative selection is illustrated (fig. 6, e-j).
(d) Two broken stone fishhook lures were also found (fig. 6, a-b).
(e) About 60 per cent of the obsidian flakes show signs of use along one or more edges. None of the flakes show use on hinge-fractures (Shawcross 1963:52). The flakes are all fairly small, and no cores are present in the collection.

Bone Fishhooks.

The most numerous bone artefacts recovered are those concerned with fish-hook manufacture. As well as cores, blanks and unfinished hooks which indicate the manufacture of fishhooks at the site, there are a number of finished broken fishhook shanks which indicate that fishing was a major activity. The principal forms are illustrated in fig. 7, a-e, g, i-k. Unfortunately no points belonging to this type of hook were found suggesting that hooks broke while fishing, but the broken hook was not discarded until the fisherman returned to the site. However, one point (fig. 7, h), presumably made from the canine tooth of a Polynesian dog, must be a point for some form of composite hook. Other kurii teeth (fig. 7, f) also show signs of working. Most of the shaped bone "blanks" seem to have been found in level III, and the majority are manufactured from the porous bone identified as whale or seal. Hooks and cores however, appear to have been scattered through all three levels.

Other Bone Artefacts.

(a) In addition, a number of pieces of bone appear to have been fashioned to points (fig. 7, p.) and served as piercing tools. These are made on flat or slightly curved pieces of bone, and have a deliberately fashioned point but no other sign of finishing or smoothing.

(b) Another piece of bone has been filed to form a fairly sharp blade along one edge (Fig. 7, O).

(c) Finally, the excavations in 1962 produced a small ring in bird-bone from layer II.

SUMMARY AND CONCLUSIONS.

Definite conclusions concerning this site are difficult to draw owing to apparent disturbances that mixed different layers. However, a general pattern does seem to emerge. The first occupation seems to have been predominantly for fishing and hunting. This is supported by a large concentration of fish-bone, and a high percentage of the birdbone associated with this occupation, and a number of fishhooks. In addition, in the very first year's excavation, a large whale vertebrae was found resting on the natural sand, and level III yielded a number of worked fragments of porous cetacean bone.

Following this occupation, some at least, of the pits and ovens occur, and are probably in part concurrent with the later occupation which left the large numbers of stone flakes, and the small adzes described above.

As this is one of the few flat areas on the island it is reasonable to assume that it would have been used for agriculture. If so, the disturbance due to this and/or other causes may have resulted in a mixing of the early "fishing" occupation and later ones. This would account for some of the bird and dog bone that appears in levels II and III but does not extend into level I in any quantity. However it could also be that this occupation does not coincide with the earliest fishing layer, as the distribution of the fishing material is not identical with that of the bird and dog bone. This would mean that the earliest occupation was strictly a fishing community, with bird and dog bone which imply hunting as well, appearing later.

After the "stone flake" occupation or possibly in its later stages European contact material occurs. Again it would seem that early contact agriculture, possibly gumdigging, and later ploughing as well, has mixed any former stratification.

It is difficult to know where the chert-flakes and 'drillpoints' fit in this interpretation. For neither of these items is the distribution statistically significant, so one may assume either that they were in use over a wider range of time than other materials, or alternatively that their distribution originally coincided with the bird and dog bone, but has been upset owing to subsequent agricultural disturbances in which the stone has survived better than the bone. In this context it is noticeable that the bone tends to become more fragmentry in the upper levels. In any case, the chert and 'drillpoint' distribution differs from that of the adze flakes, stone flakes and obsidian. If the assumption is made that the 'drillpoints' and chert coincide roughly with the bird and dog bone, the picture that emerges would be:

(a) Occupation in which European contact material occurs in mixed deposits that approximate to level I but on occasions extend into level II.

(b) Occupation in which stone flakes, adzes and obsidian flakes predominate. The large shell mounds nearby may be associated with either this occupation or the one above. The occupation probably

coincides with the upper six inches of layer II before subsequent activities obscured the stratification.

(c) Occupation in which bird and dog bone predominates and at which time at least some of the pits and *haangi* were made. There is some evidence for fishing and it seems likely that a majority of the chert and 'drillpoints' are to be placed here. This occupation includes most of level II and an indeterminate part of levels I and III. It is possibly coterminous with the lower part of layer II.

(d) A fishing occupation with fish, whale, and other porous bone in which most of the fishhooks and items associated with their manufacture are to be found. This occupation includes all of level III and portions of the lower part of level II. It probably coincides with layer III.

This division is in terms of *quantitative* distribution and concentrations only, and it is not meant to imply that the materials named are confined exclusively to the one occupation. The proposed separation does not provide much correlation between the distribution of flaked points, sometimes called drills, and the fishhook bone material that is normally assumed to have been worked with them. However, the distribution in Table I does not indicate that there was much correlation either and it may be that our functional interpretation is in error. Also the relatively small amount of worked bone to the large number of 'drillpoints' does tend to suggest that they were used on a wider range of material.

Finally, possible datings for the sequence outlined above must be considered. One end of the time scale is anchored by European contact material. Unfortunately it has not yet been possible to definitely ascertain a date of manufacture for this material, although it is considered that the china recovered was more likely to have been manufactured in the earlier rather than the later part of the 19th century (V. F. Fisher, personal communciation). No carbon samples were taken and obsidian dating has produced only general results that may be equated with sites dating to the 14th century or later. Green (1963, p. 54) assigned level and layer III of this site to the Developmental Phase in the sequence he outlined for the Auckland Province. For the next part of the sequence there are few good criteria for dating other than proportions of obsidian and the change from the evidence for hunting (excluding the moa) to its lack and the suggestion that agriculture may have been involved in the mixing of deposits. If the next occupation of stone and obsidian flakes and small flake adzes, lacking entirely in archaic forms, and providing none of the 'classic' 2B types, is assigned to any phase, it will likely be on the basis of these adzes, if they prove to be of more than local significance.

Green in personal communication says he would place this last occupation in the proto-Maori phase because it lacks any forms typical of archaic assemblages and exhibits no evidence for the former strong reliance on fishing and hunting, while indicating a strong possibility for agriculture in the nature of the small adzes more relevant to garden clearing than woodworking, which is in keeping with the postulated agricultural disturbances of the site. Also in his obsidian chronology for the area it seems likely that this level is to be placed in time with other sites also assigned to this phase. The final occupation Green (1963, p. 86) assigns to the Early European Maori phase.

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TABLE I

Site N 43/1 — Distribution of material by level

Item and Number		Chi-square result	Level I—%	Level II—%	Level III—%
Stone flakes—	1325	P <.01	51	38	11
Adze flakes—	40	P.05> .01	52	35	13
Roughouts for adzes—	8	——	75	12.5	12.5
Modified stone flakes—	10	——	60	20	20
Chert flakes—	251	P > 05	35	40	25
Drill points—	26	P > .05 (not significant)	52	27	21
Files—	7	——	60	30	10
Obsidian flakes—	326	See below	54.9	33.8	11.3
a. Grey obsidian—	122	P <.01	24.2	9.8	3.4
b. Green obsidian—	204	P <.01	30.7	24.0	7.9
Fishhook materials—	46	P <.01	15	23	62
Fish jaws—	105	P <.01	0	3	97
Dog bone—	57	P <.01	7	57	36

TABLE II

Site N 43/1 — Distribution of identifiable bone

Common Name	Binominal Designation	Level I	Level II	Level III
Dog (Polynesian?)	Canis familiaris	X	X	X
Polynesian rat	Rattus exulans	—	—	X
Pig (European?)	Sus scrofa Linné	X	X	—
Albatross	Diomedea sp.	X	—	—
Shag	Phalacrocorax sp.	—	X	X
North Island weka	Gallirallus australis greyi	—	X	X
N.Z. pigeon	Hemiphaga n. novae-seelandiae	—	X	—
N.Z. tui	Prosthemadera novae-seelandiae	—	—	X
Duck—N.Z. teal	sp. unknown	—	—	X
Moa	Dinornis sp.	—	X	X
North Island Kiwi	Apteryx australis mantelli	Position not known		

Two Unusual Maori Carvings from Northland

By GILBERT ARCHEY

In this brief notice we have the pleasure of describing two unusual objects, both from Northland, presented to the Museum: a canoe stern-post of unique form given by Mr. T. Wallace of Tokerau Beach, Doubtless Bay, and the decorated base for an elevated storehouse, the gift of Mr. Lacy M. Neilson of Kohukohu.

Elevated Store-house Base.

The placing of food, treasures, offerings or mortal remains in a receptacle set high on a pole was a common practice in Polynesia (Cook, 1784; pl. 25, Tahiti; Webber, 1808, pl. 6, Tahiti, pl. 8, Huahine). Early

Fig. 1

accounts of New Zealand sometimes include one such in an illustration: our text-figure 1 is copied from a drawing in Earle's 'Narrative of a Nine Month's Residence in New Zealand in 1827'; Duperray (1826, pl. 41 : 3) illustrates portion of a canoe used as the upraised repository; Angas (1847) portrays several types (Frontispiece; pl. 8; pl. 30; they are repeated in White, 1891); Taylor's record (1855; 32) is of the tomb of Heu Heu; in a Charles Heaphy drawing of 1839 in our library, a small pole-pataka appears above the palisade of a fighting *pa* built at Waitangi, Chatham Islands by the Maori invaders who had then come to inter-family conflict; Best (1916: 48-49) briefly describes the elevated *pataka*.

These descriptions and illustrations provide no more than a general outline of the form of the receptacle itself; even the best of them (our copy fig. 1), which clearly shows the contact or insertion of the supporting shaft, gives no hint of the craftsman's technique for securing a junction tight enough to prevent a large box—really a small building—from wobbling or coming adrift. In a few illustrations diagonal stays are shown. There are no sockets in the present example to receive such supports, but a square recess and a continuing mortise to receive the pole from below give some understanding of the method employed though with speculation as to detail.

Description.

A heavy slab of totara (Fig. 2) 141 cm. long, 36.7 cm. wide, 13.0 cm. thick at the centre, with a large central rectangular boss projecting a further 10 cm. downward; at the sides or edges, which are slightly bowed outward, the thickness is 7.0 cm. The total length comprises the main rectangular slab, 113.5 cm.; and heads projecting 13.0 and 14.5 cm. at the ends, each borne on a neck, recessed presumably for lashing.

The lower surface and the edges are fully carved; the smoothed upper surface has a shallow (1.0 cm.) rebate across either end, four rectangular mortised holes close to the edge on one side and five on the other. Where the rectangular (9.2 x 7.0 cm.) mortise for the supporting pole or shaft appears at the upper surface (Fig. 3) a rebate 4.7 cm. wide slopes down into each longer side to about 1 cm. depth. I have studied these details with Mr. Trevor Bayliss, and we conjecture that they are clearances for a pair of wedges driven into recesses, or more likely a hole right through the pole (Figs. 4 and 5), to tighten the junction. A through perforation instead of recesses would require some upward extension of the pole to hold the strain.

Slabs laid across the upper surface, the middle one probably pressing down upon the wedges, and lashed somehow through the edge mortises, would form the pataka floor (Fig. 6). We cannot be certain as to which side would have been front, back or sides, for the rebate at either end of the base would presumably have received either. But we should not expect the carved heads to project from under the *paepae* of the front nor at the back; moreover the projecting heads borne

Fig. 2

on the cross bearers of the Te Oha *pataka* (assembled 1825) in this Museum, suggest a construction such as that indicated in text-figure 7.

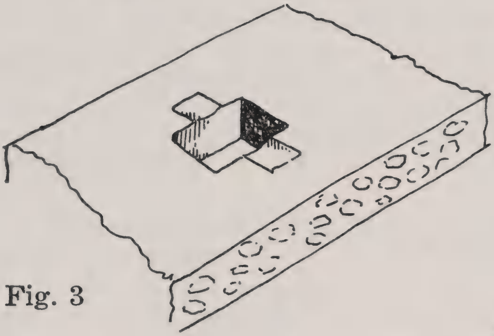

Fig. 3

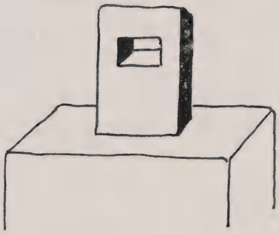

Fig. 4

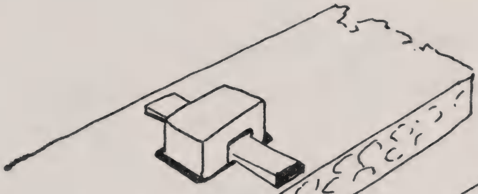

Fig. 5

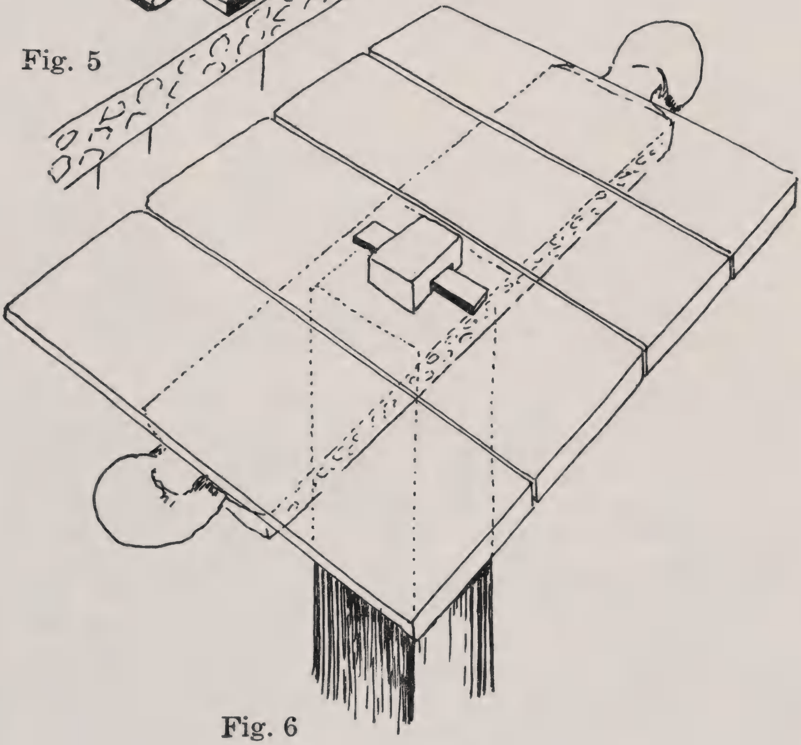

Fig. 6

Decoration. (Figs. 8-10)

A full-face human figure in relief covers each side from the central boss to the end where the head sculptured in the round projects as already described.

The flat shoulder discs and thighs are each covered with a lightly carved double spiral. From the shoulders the slender tapering arms curve first inward and then outward where they reach the outer edge of the thigh disc. A slender fore-arm slopes upward to a band-shaped hand with two tapering fingers lying on the side of the body. Connecting chocks can be distinguished from the fore-arm by the straight shallow grooves carved on them.

The legs are narrowed below the thigh areas; they end on the slope of the boss; indications of feet, if any, have been abraded away.

Flanking the figures, the slab carries a 5 to 7 cm. wide outer border of interlocking or alternating loops, some simple others S-shaped,

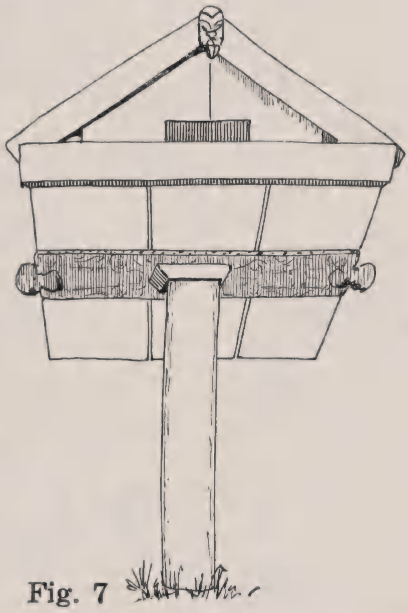

Fig. 7

the pairs being joined by connecting chocks distinguishable from the loops themselves by being straight and bearing a couple of straight shallow grooves. The only hint that the loops might be of limb origin is that one of them, on the edge of the slab, terminates in two tapering finger-like processes. In a similar pattern along the edge (Fig. 9) the loop-alternation is more regular and bears more consistently a small detail, namely rhomboidal depression (c 2.5 cm. x 1.5 cm. to c 3.5 cm. x 2.5 cm.) at approximately where the horizontal connecting chocks join the loops. A secondary decorative order appears in that the spaces cut down between the loops and the chocks come into a pattern of rhomboids repeated in oblique rows 2-3-2-3- etc. along the edge. Indeed, in the present somewhat blurred condition of the borders of the loops, this pattern of deep rhomboids is dominant; incidentally the mortised

Fig. 8

Fig. 9

lashing holes along the edge of the slab find their places within this order. The whole gives a distinct sense of planned design. As for its relationship we might compare the elements with the loops of Taranaki *pare* background detail (Archey 1960, pls. 42-43), but I would not stress the resemblance.

All the carving outlines are blurred or softened by abrasion or decay; very little remains of the head detail but I would hazard a pristine face-rendering somewhat as outlined in text-figure 10.

Stern-post (taurapa). Figs. 11-13.

The canoe stern-post presented by Mr T. Wallace, was discovered by him in 1959, while discing on a farm at Tokerau Beach at the northern end of Doubtless Bay. All other simple sternposts known have the general outline of the large decorated *taurapa* of the war-canoe, that is of a *plank* narrow from side to side, curving gently upwards and backwards in prolongation of the after-sheer of the canoe (cf. Fig. 11; sternpost in Taranaki Museum). The Doubtless Bay *taurapa* more than any of these, is literally a stern-post (Fig. 12) narrow and round or

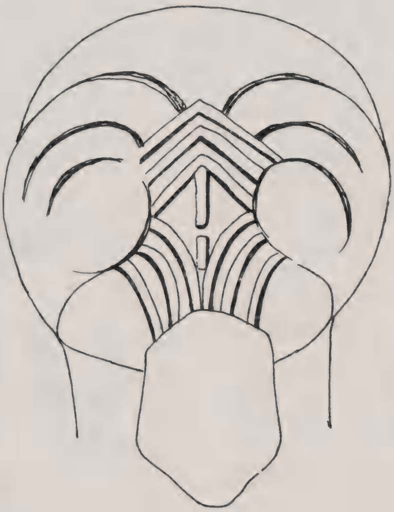

Fig. 10

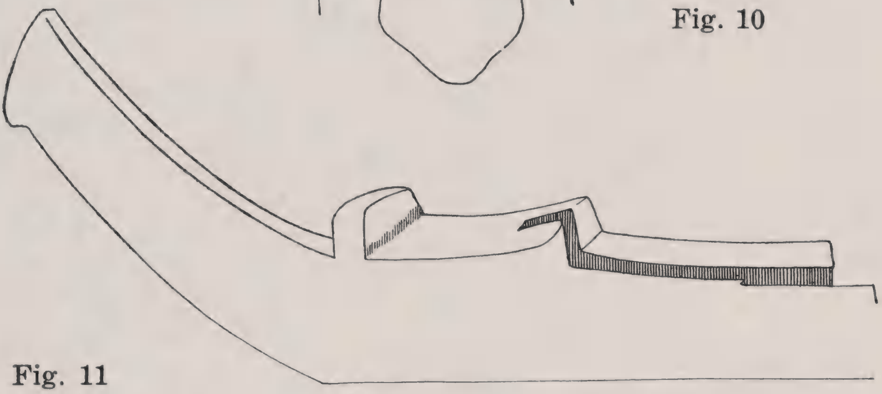

Fig. 11

elliptical in section of sufficient thickness to act as a firm rest against which to lay the long steering paddle.

The wood appears to be *pohutukawa*, *Metrosideros excelsa*, somewhat knotty or irregularly grained and, of course, hard and strong. It must have been tough to shape and carve, but a piece of timber already of helpful outline may have been selected for it. Its dimensions are given with the outline drawing of text figure 12.

The base is a typical stern-cover, hollowed beneath for the lashing which would have passed through the square-chiselled holes, four on the port side and three on the starboard. It is 26 cm. wide at front, and 18.5 cm. across the two carved projections at A-A1. The additional holes cut through the upper edge might have been for mast-rigging, which, if so, would imply a sailing canoe.

The upward-curving post itself is half-elliptical in section, chamferred 10 cm. wide in front and sharp-edged behind. It is expanded terminally where a dog-like creature (Fig. 13) with curled tail is carved on the port side, the other being smooth. The creature has a manaia-type profile face; its fore-limb is thrown up and back in an attitude more human than quadrupedal. The face has a round eye under an evenly arched eyebrow which terminates below in a flat boss in the position of an ear. Projecting backward from the eyebrow are three long spines recalling the projections on a canoe-prow of unusual form,

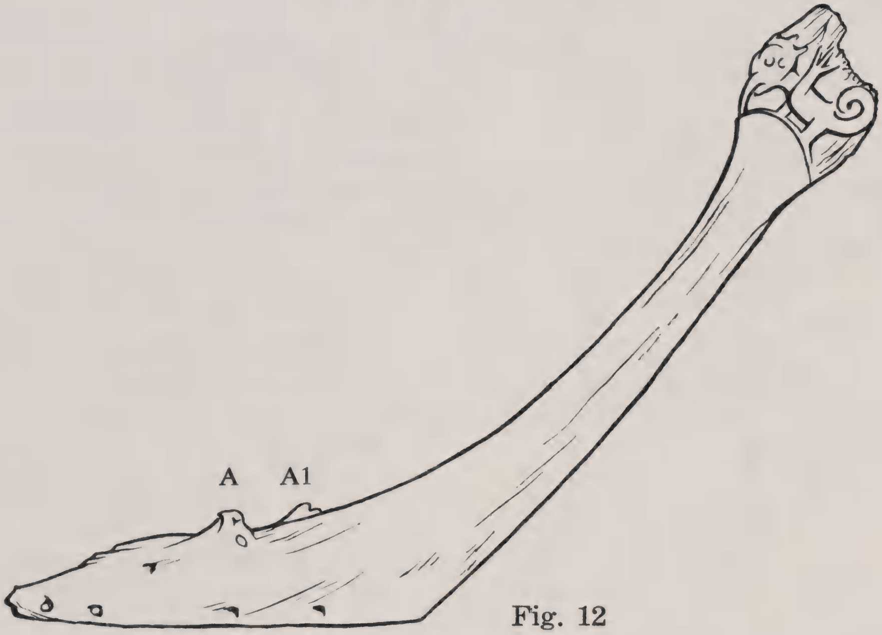

Fig. 12

Fig. 13

Dimension of stern-post, fig. 12: Length 92.1 cm.; height 61.0 cm.

also from Doubtless Bay, previously described by the present writer (Archey, 1933: 209-211).

Two triangular profiles (Fig. 12A, A1) of distinctly bird-like form project from each side of the upper edge of the base. They, and the 'dog' face, are carved in somewhat the same style as the faces of the Doubtless Bay prow, though not with point-by-point detailed similarities.

The strongly curved upper jaw of the 'dog' and its nearly straight lower jaw are present, for example, in the small figure behind the main head of the prow; the eyes however are different—round in the 'dog' and elliptical in both large and small heads of the prow. The 'dog' and the small prow head both lack the teeth which are so prominent in the main head of the prow, where also the backward projecting eye-brow spines of the "dog" appear as forward projecting triangular eyebrow studs.

These slightly varying similarities have an interest, and a significance in relation to the fact that both carvings came from the same swamp, but at an unkown distance apart. The prow was discovered during the first draining of the area in 1933 by the then owner of the property, Mr. T. Neilsen, who has been dead several years, and Mr. Wallace cannot say where in the swamp it occurred. The general resemblances however, including the same timber, and the fact that Mr. Wallace disced the whole former swamp area without finding another specimen, indicate the strong possibility that we have here the *taurapa* and *tauihu* of the same canoe.

Structurally each is typically Maori: a bow-cover and a stern-cover with projecting head in the one and a post to bear the steering paddle in the other. One feature, straight sharp-pointed fingers, the stern-post shares with a carved slab from a swamp at Awanui only ten miles distant, also described by the present writer in 1933 (p. 210); in other respects however, particularly in the form of the eye, the Awanui slab stands closer to the prow than to the stern-post. Nevertheless all three are undoubtedly of the same general style or school, known so far from but one restricted Northland area.

As director at the time these articles came to the Museum I take the privilege of expressing our grateful thanks to Mr. Neilson and Mr. Wallace for their generous gifts of two such unusual and interesting examples of Maori art and workmanship. My personal thanks are given to Mr Bayliss for his valuable contribution to constructional interpretations and to Mrs. Betty Brookes for giving them such admirable portrayal.

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The Family Eatoniellidae in New Zealand

By W. F. PONDER,

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Abstract

A new family, the *Eatoniellidae* is proposed and 23 new species, 5 new subgenera and 3 new genera are described. Classification of the 43 New Zealand species has been based, where possible, on a combination of the morphology of the shell, the operculum, the radula and the exposed animal.

Introduction

Hutton (1882) described the external features of the animal, radula and operculum of a small black mollusc he called *Dardania olivacea*. Suter (1913) included this species in *Eatoniella* Dall, 1876, a genus erected for *Eatonia kerguelenensis* Smith, 1875, which has a similar operculum and radula. Iredale (1915) erected *Dardanula* for *Dardania olivacea* Hutton, as Hutton's genus was preoccupied, with the explanation, "The operculum differs at sight from that of *Eatoniella,* so that a generic distinction must be allowed." The operculum of the type of *Eatoniella,* in fact, differs from that of *Dardanula olivacea* only in a few minor details. The shells and radulae of several species of *Dardanula* do show small, but constant, differences from *Eatoniella* s.s. so that the name *Dardanula* is retained as a subgenus of *Eatoniella. Pellax huttoni* (Pilsbry), a species previously classified in the Phasianellidae because of its colour pattern, is also included in *Eatoniella,* with *Pellax* Finlay (1927), reduced to subgeneric level. The anatomy of *E.* (*D.*) *olivacea* and *E.* (*P.*) *huttoni* will be described elsewhere (Ponder, —a.). They differ from any other known prosobranch in the combination of characters they possess, as shown below, and a new family, the Eatoniellidae, is erected for them.

The eatoniellids are the dominant, small, algal dwelling molluscs on New Zealand shores. They are micrograzers and microdetritus feeders, scraping the diatomaceous film from the subtratum over which they crawl. A few species are restricted to fairly deep water, but the majority are found in the lower littoral zone. Many of the species discussed below are new, as their similar appearance has made separation on shell characters alone, difficult.

The New Zealand species have previously been classified in *Dardanula, Notosetia, Estea, Zeradina, Pellax, Epigrus* and *Skenella.*

Various genera have been classified near *Eatoniella* by Coan (1964), because they were believed to possess an opercular peg, but most are in no way related (see Ponder 1965, b and d). These include

Barleeia Clark, *Boogina* Thiele, *Diala* A. Adams (*"Diala" marmorea* Carpenter has an opercular peg, but this species together with other North American *"Diala"* species, belong to a new genus related to *Barleeia*, true *Diala* having a simple operculum), *Eatonina* Thiele, *Eatoniopsis* Thiele, *Hemistomia* Crosse, *Tatea* Tenison-Woods and *Rissoina* d'Orbigny.

The evolution of the opercular peg has obviously occurred several times in very different lines of evolution, involving at least three superfamilies—the Neritacea, Littorinacea, and Rissoacea. The advantage of such a structure must be considerable and, in most cases, is concerned with the attachment of a branch of the columella muscle, to allow rapid withdrawal of the animal into the shell. In most instances the pegged operculae are much more solid than are simple operculae in related genera. For example *Rissoina* has a solid pegged operculum, while that of *Zebina* is thin and simple. *Tatea* and *Hemistomia* have produced a different type of peg, a calcareous deposit on the thin horny operculum, which only doubtfully functions in the same way as that of *Eatoniella*. With the development of a peg, the corresponding thickening of the operculum is correlated with the necessity for a strong surface of attachment for the peg and its muscles so that force on the peg will move the whole operculum.

Other groups that have evolved opercular processes are the *Scrobs-Anabathron* group (Rissoidae), which has a small raised ridge on the middle of the columella edge, and a new family (Ponder,—c.) which has an operculum very like that of *Eatoniella*. The opercular peg is clearly a structural modification evolved in several prosobranch groups, and should be used with caution as an indicator of phylogenetic relationship.

THE TERMINOLOGY OF THE ANIMAL, OPERCULUM AND RADULA

As the descriptive terminology of the animal, operculum and radula is rather unsettled, brief definitions of the terminology used are given. The definitions are restricted to the littorinacean—rissoacean type of animal, an oligogyrous operculum and a taenioglossan radula. Some of the terms are illustrated in text figure 1.

Animal

Head

Cephalic tentacles—paired tentacles arising from the head.

Snout—an anterior protuberance of the head, which bears the mouth terminally.

Foot

Propodium—a dorsal flap situated on the anterior end of the foot.

Mesopodium—the anterior half of the foot.

Metapodium—the posterior half of the foot.

Opercular lobes—the fleshy, lateral lobes bearing the operculum.

Accessory Tentacles

Opercular tentacle—tentacle arising from the opercular lobes.

Caudal tentacle or metapodial tentacle—tentacle arising in the mid-dorsal line, posterior to the opercular lobe.

Pallial tentacle—tentacle arising on the edge of the mantle cavity.

Pedal Mucous Glands

Anterior mucous gland—situated and opening between the pro- and mesopodium.

Sole gland—a collection of subepithelial gland cells opening between sole epithelial cells.

Posterior mucous gland—a gland in the central part of the foot that opens into the metapodium.

Mucous slit or mucous pore—the opening of the posterior mucous gland.

Operculum

Orientation

Right and left ends—are those edges on the extended animal's right and left side respectively.

Columella edge—the edge against the inner side of the aperture when retracted. or the anterior edge when extended.

Outer edge—the edge against the outer side of the aperture when retracted of the posterior edge when extended.

Morphology

Nucleus—the coiled portion, involving all but the last, or major, coil.

Last whorl—the last, or major, coil of the operculum.

Columella marginal area—a distinct area, not always present, along columella edge.

Outer marginal area—as last, on outer edge.

Muscle insertion area—the area of muscle attachment on the inner side of the operculum is often a distinguishable surface which is roughened and/or opaque.

Internal ridge—a strong ridge running parallel, but somewhat internal to, the the columella edge.

Peg—an outgrowth, or apophysis, from the inner surface of the operculum.

Sculpture

Growth Lines—the natural growth curves.

Spiral lines—run in the same direction as the coiling of the operculum.

Description

Thickened—(when term applied to whole operculum) not readily pliable, (when applied to a certain area) thicker than the majority of the operculum.

Curved—bent when viewed from the side.

Concave and Convex—the direction of curve taken from the outside surface.

Radula

Teeth

Central—(rachidian or median), the middle or first tooth of the radula row.

Lateral—the second tooth of the radula row (paired).

Inner marginal—the third tooth of the radula row (paired).

Outer marginal—the fourth tooth of the radula row (paired).

Orientation

Outer—towards the outside of the ribbon.

Basal or Ventral and—

Upper or Dorsal—taken as if the tooth were upright with the cutting edge uppermost.

Lateral—both sides of a tooth.

Minor Terminology

Cutting edge—edge with cutting processes.

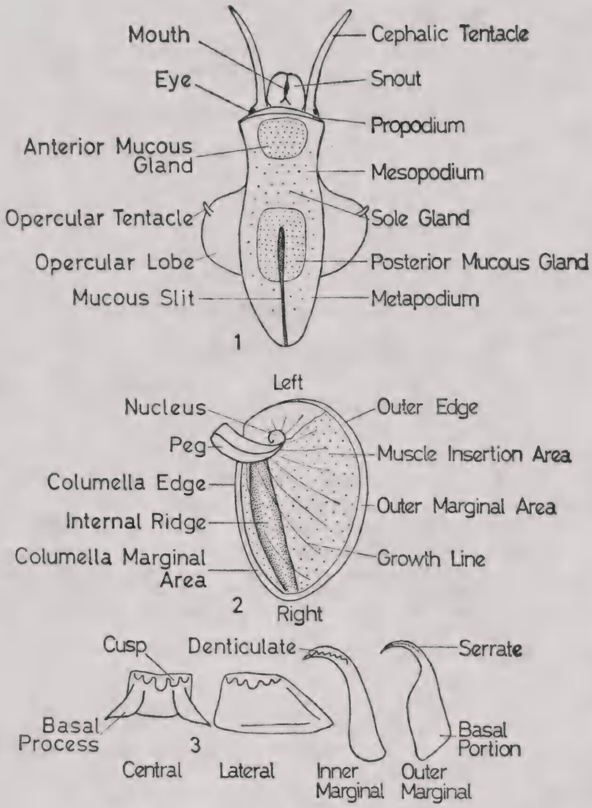
Cusp—a large, distinct cutting process.

Denticle—a small, indistinct cutting process.

Serrations—fine, numerous cutting processes.

Process—a thickened portion, at least partly separate from the tooth, and not involved in the cutting edge.

Cusp Formula—is written in the order:—small lateral cusps—large main cusp—small lateral cusps.



TERMINOLOGY

Fig. 1. Animal (ventral view).
2. Operculum (inner side).
3. Radula.

The shell, animal, operculum and radula are described for each species as far as they are known. In most cases the specimens of which the animal was observed and the operculum and radula obtained, were collected in the same locality, which is given in brackets after the heading 'animal'. If, however, the radula and/or operculum examined was from an animal from a different locality, this locality is added in brackets after the headings 'operculum' or 'radula', as the case may be. All of the figures of shells in the plates are to scales.

Abbreviations

A.M.—Auckland Museum; Cant. Mus.—Canterbury Museum; Coll.—Collection; D.M.—Dominion Museum; G.S.—Geological Survey; O.I.—Oceanographic Institute.

Eatoniellidae n. fam.

Shell: Simple, conical, usually smooth, rarely spirally sculptured. Protoconch usually smooth, not distinctly marked off from adult shell. Aperture simple, ovate, not distinctly angled. Outer lip often strongly excavated.

Operculum: Oval to ear shaped; nucleus small, marginal indistinct; convexly curved; a thickened curved peg emerging from the nucleus and extends past columella edge.

Radula: Central large, approximately square, with two strong basal processes, cusps few. Lateral tooth short, approximately rectangular, with few cusps. Inner marginal narrow, curved, with larger and fewer cusps than outer marginal. Outer marginal finely serrate, terminal half strongly curved, basal half abruptly expanded. Jaw strong, a series of chitinous rods.

Animal: Cephalic tentacles long, mobile; eyes on swellings at outer bases of tentacles. Snout bilobed, mobile. Sole with a prominent mucous slit in posterior half into which a posterior mucous gland opens. Anterior and sole mucous glands also present. Opercular lobe sometimes with short tentacles developed on right and left or left sides. No caudal or pallial tentacles.

Mantle cavity with osphradium, monopectinate gill, and hypobranchial gland all well developed. Prostate and pallial oviduct open. No penis in male. Large glandular structures, possibly homologous with oesophageal pouches open into posterior end of buccal cavity of *Littorina*. Oesophageal glands present, stomach with style sac but no crystalline style.

The *Eatoniellidae* differs from any other described family in the combination of the following major characters:—the simple conical shell, the pegged operculum, the 'littorinid' type of radula, the presence of opercular tentacles in some species, the aphallate males, and the open prostate and pallial oviduct. The *Littorinidae* has an open prostate but the pallial oviduct is closed while the males of this family and the *Lacunidae* are phallate. The *Rissoidae* has both the prostate and pallial genital duct closed and a phallate male, while the *Cingulopsidae* is characterised by the aphallate male, but the female has a closed pallial oviduct.

Skenella Martens and Pfeffer, 1886, and *Cerostraca* Oliver, 1915, and possibly *Lucidesta* Laseron, 1956, and *Mesodesta* Laseron, 1956, belong in the *Eatoniellidae*.

A KEY TO THE GENERA OF THE EATONIELLIDAE

Genus	Shell	Operculum
Eatoniella	Ovate-conical, smooth, moderately thick to thin.	Muscle insertion area opaque and distinct.
Crassitoniella (nov.)	Ovate-conical, smooth or with a weak peripheral spiral cord, thick and solid.	Muscle insertion area indistinct and transparent.
Liratoniella (nov.)	Elongate ovate-conical, rather solid, with a few strong spiral cords.	Muscle insertion area, opaque and distinct.
Skenella	Small, depressed, spire almost flat, thin.	Muscle insertion area indistinct, transparent.
Pupatonia (nov.)	Minute, white, pupoid, with fine, dense, spiral sculpture.	Unkown.

A Summary of the Key Characters of the Subgenera of Eatoniella

By using the characteristics of *Dardanula* as a basis, only the points distinguishing each *subgenus* from *Dardanula* are given. A dash shows that the details are largely unknown.

Subgenus	Shell	Animal	Operculum	Radula
Dardanula	Solid, ovate-conical, variously coloured, imperforate or very narrowly umbilicate. Peristome thickened, outer lip straight or retracted. Protoconch opaque.	0-1 opercular tentacles on left lobe, no definite group of mucous cells on right lobe.	Muscle insertion area extensive, only a narrow outer marginal area. Spiral sculpture weak or absent. Black, brown or yellowish. Internal ridge present or absent.	Central and lateral with few large cusps. Inner marginal with few cusps (1-6 usually 3), S-shaped; outer marginal with a broad basal area.
Abscindostoma (nov.)	Large, rather thin, outer lip strongly retracted.	1 opercular tentacle on left lobe, a definite group of mucous cells on right lobe.	Yellowish-white. No spiral sculpture. No internal ridge.	
Albitoniella (nov.)	Pale coloured.	—	Yellowish-white. No internal ridge.	Marginal with many small cusps (3 + 1 + 5), inner marginal simple, a simple curve (not S-shaped). Outer marginal with basal portion only weakly expanded, not serrate.
Albosabula (nov.)	Small, solid, white.	—	Yellowish-white. No internal ridge.	Inner marginal nearly straight, finely denticulate (6-9 denticles).
Cerostraca	Small, thin, posterior corner of aperture bent downwards rather strongly; usually a varix-like thickening just behind aperture	0-1 opercular tentacles on left lobe, a definite group of mucous cells on right lobe.	Yellowish-white. No internal ridge.	5 denticles on inner marginal.
Caveatoniella (nov.)	Small, thin, aperture separate from body whorl, distinctly umbilicate.		White. No internal ridge	
Dardaniopsis (nov.)	Small, thin, globose, outer lip bisinuate.	1 opercular tentacle on each lobe.	Muscle insertion area broken some distance from outer margin. Yellowish-white. No internal ridge.	Inner marginal with 4-7 denticles.
Eatoniella	Large; protoconch semi-transparent, colourless. Adult whorls dark coloured.		Spiral striae rather distinct. Yellowish-white. Weak internal ridge.	Inner marginal with 5-7 denticles.
Pellax	Very large, red with white markings.	Red, 1 opercular tentacle on each lobe, a group of mucous cells on right.	Reddish-brown. No internal ridge.	Inner marginal with a broad base.

Genus **Eatoniella** Dall, 1876 (nom. nov. pro Eatonia Smith, 1875, non Hall, 1857).

Type (s.d. Suter, 1913): *Rissoa kerguelenensis* Smith, 1875.

Shell: Small to minute, usually rather solid, smooth, whorls weakly to moderately convex. Protoconch smooth, dome-shaped, not distinctly marked off from adult whorls. Aperture ovate, D-shaped, or pyriform, peristome moderately thickened, usually not reflected, outer lip usually suddenly bent downwards posteriorly, straight or excavated below. Perforate or imperforate. No sculpture apart from growth lines, and, sometimes, faint spiral scratches.

Animal: As described for family. Opercular lobe with or without a single opercular tentacle on each side.

Operculum: Oval to pyriform; muscle insertion area distinct, opaque; peg strong, usually grooved, extending beyond columella margin, at a moderate angle to horizontal plain of rest of operculum. Nucleus small. Columella margin flat to convex, never strongly convex.

Radula: As described for family.

Subgenus **EATONIELLA** (s.s.)

The following account applies only to the New Zealand species, as I have only examined the shell of the type, which is from Kerguelen Island, and the available descriptions of the radula and operculum, especially the latter, are not very comprehensive. However, these structures appear to be very similar to the New Zealand species of the subgenus.

Shell: Large, imperforate, whorls weakly convex, dark grey or purplish-black. Protoconch semi-transparent, colourless. Peristome moderately thickened, outer lip a little retracted.

Animal: Details unknown, though generally similar to other members of the family.

Operculum: Spiral sculpture rather prominent, internal ridge weak or absent, a distinct longitudinal line breaks muscle insertion area at its outer edge near right end. Colour yellowish.

Radula: Central 3 + 1 + 3; lateral 2 + 1 + 3; inner marginal 5-7 denticles, outer marginal with a thick portion at ventral end, finely serrate, basal half expanded.

Eatoniella kerguelenensis chiltoni (Suter). Pl. 4, figs. 2-8.

1909 *Rissoa chiltoni* Suter, Subantarctic Is. N.Z. 1, p. 18, pl. 1, fig. 2.
1913 *Rissoa* (*Eatoniella*) *chiltoni* Suter; Suter, Man. N.Z. Moll. p. 223, pl. 13, fig. 15.
1915 *Dardanula chiltoni* (Suter); Iredale, Trans. N.Z. Inst., 47, p. 454.
1955 *Dardanula chiltoni* (Suter); Powell, Cape Exped. Series, D.S.I.R., Bull. 15, p. 87.

This species has a much wider distribution than was previously realised. Specimens from the Chatham Islands, though very variable (figs. 2, 3), are very similar to typical shells. The species also occurs

in Dunedin Harbour (fig. 6) where it is probably relict from a colder period.

E. kerguelenensis (Smith) from Kerguelen Island (pl. 4 fig. 1) has also been recorded from Macquarie Island (Tomlin, 1948, B.A.N.Z.A.R.E. Ser. B., 5(5), p. 226) but I have not seen the specimens. *Chiltoni* is very similar to the Kerguelen shell and, in my opinion, should be regarded as a subspecies of it. There is nothing in the available description of the radula and operculum that disagrees with this conclusion.

The holotype of *chiltoni* is a rather large shell with weakly convex whorls, a transparent white protoconch and dark grey coloration. It has a small umbilicus and the outer lip is slightly retracted. The columella and the last part of the body whorl are light grey and the inside of the aperture is blue-grey. The colour is fairly constant, though often there is a faint yellow line below the suture and the intensity of the grey is rather variable and sometimes has a reddish tinge. The shell size, shape, and the convexity of the whorls and the presence of an umbilicus are all variable features. However, the subspecies is easily distinguished by the large, thin, light shell, greyish colour and large transparent-white protoconch. The latter feature is especially useful in the identification of juveniles.

Animal: (Campbell Island). Cephalic tentacles long, tapering, yellowish; eyes moderately large at their outer bases, with a patch of black pigment behind. Snout bilobed, black except for terminal lobes which are yellowish (probably white in life). Opercular lobe dense black. Mantle not pigmented. There do not appear to be any opercular tentacles. (Preserved material).

Operculum: (Fig. 8): Oval, yellow, muscle insertion area large. A very weak, rather irregular, internal ridge which makes a small break in muscle insertion area at outer marginal area near right end. Growth line weak and fine spiral sculpture present. Peg of moderate size. A distinct spiral line emerges from nucleus and continues for a short distance. Marginal area rather narrow.

Radula: (Fig. 7). Typical of the genus and very similar to that of *E. kerguelenensis kerguelenensis* (see Thiele, 1912). Central 3 + 1 + 3, oval with two basal processes. Lateral 2 + 1 + 3, wide, with a solid basal projection and a strong ridge on the upper margin. Inner marginal with 5 denticles, outer with about 8 fine serrations and a wide basal half.

Holotype: (Fig. 5). Campbell Island, Coll. C. Chilton (Cant. Mus.). Height 2.53 mm. Width 1.5 mm.

Material Examined:

Holotype; Ships' Channel side of Quarantine Island, Dunedin Harbour, Corallina, brown algae, fine red algae, 4/5/63 (W.F.P.); Portobello, Dunedin Harbour, 2-3 fathoms, Finlay Coll. (A.M.); Dunedin Harbour, Finlay Coll. (A.M.); Portobello, brown algae, Corallina, under stones, 3/9/63 (W.F.P.); Snares Islands, under stone, G. A. Knox, 29/1/61 (D.M.); Faith Harbour, Auckland Islands, beach drift (A.M.); Campbell Island, Cape Expedition, J. Sorensen (A.M.); N.Z.O.I. Stat. D.2, Garden Cove, Campbell Island, shore algae (O.I.); Waitangi, Chatham Islands in pools and on algae, W. R. B. Oliver, 8/12/09 (D.M.); Waitangi, A. W. B. Powell, —/2/33 (A.M.); Chatham

Island Exped. Stat. 16, Kaingaroa, 27/1/54 (D.M.); Chatham Island Exped., Port Hutt, Chatham Islands, shell sand, 8/2/54 (D.M.); Chatham Islands Exped. Stat. 13, Owenga, 4-6 fathoms, 27/1/54 M.V. "Alert" (D.M.); Tioriori, Chatham Islands, Dell Coll. (D.M.).

Distribution: Dunedin Harbour and the Snares. Auckland, Campbell and Chatham Islands.

Eatoniella (Eatoniella) stewartiana n.sp. **Pl. 4, figs. 9, 10.**

Though closely related to *E. kerguelenensis chiltoni* (Suter), the new species differs in its smaller size, relatively larger aperture, thinner, semi-transparent shell, rounded body whorl more convex whorls, and false margined sutures. The outer lip is evenly and fairly strongly retracted. The protoconch is transparent pale grey, and the rest of the shell purplish black. There is a pale band below the suture.

Animal: (Paratype). Exposed parts unpigmented, apparently very pale pinkish. The mantle cavity roof is black. Buccal mass pale yellowish. (Dried material).

Operculum: (Fig. 10). Rather thin for genus, curved, with no thickened ridge internally, yellow, with faint spiral sculpture. A longitudinal distinct line breaks the muscle insertion area, near the right end of the outer side. A spiral line emerges from the nucleus at the left end. Peg a little longer than that of *E. chiltoni.* A marginal area distinct on all edges.

Radula: Similar to that of *E.* (*E.*) *kerguelenensis chiltoni.* Central 3 + 1 + 3, lateral 2 + 1 + 3, inner marginal with 7 denticles.

Holotype: (Fig. 9). Ocean Beach, Stewart Island, in *Brostrycia* near high tide, -/7/62 (ex Smith Coll.) (A.M.). Height 2.0 mm. Width 1.15 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, and Smith Collection.

Material Examined:

Holotype and paratype; 1½ fathoms off Portobello, Dunedin Harbour, 3/9/63 (dead shells) (W.F.P.); Ship's Channel side of Quarantine Island, Dunedin Harbour, *Corallina,* 4/9/63 (W.F.P.); Taieri Beach, algae, Finally Coll. (A.M.); Riverton, Finlay Coll. (A.M.); Bluff Harbour, *Corallina,* M. Spong, 27/5/63 (W.F.P.); Leask's Bay, Stewart Island, algae (Powell Coll.); Mason Bay, Stewart Island, algae, -/4/58 (Smith Coll.); Lee Bay, Stewart Island, *Corallina,* -/1/55 (Smith Coll.); Halfmoon Bay, Stewart Island, algae, E. Smith, 12/6/52 (W.F.P.); Aker's Point, Halfmoon Bay, M. Spong, 22/2/63 (W.F.P.).

Distribution: The South East of the South Island and Stewart Island living in algae in most of the intertidal zone.

E. (*E*) *stewartiana* is closely allied to *E.* (*E.*) *kerguelenensis chiltoni,* and seems to replace it at Stewart Island and Southland. Both species are found in Dunedin Harbour, though *E.* (*E.*) *stewartiana* is much less common.

Subgenus **Abscindostoma** n. subgen.

Type: *Rissoina olivacea* var. *lutea* Suter, 1908.

Shell: Large, rather thin, imperforate. Whorls weakly convex. Peri-

stome rather thin, outer lip strongly and evenly retracted. Colour variable.

Animal: Left opercular lobe with 1 tentacle, right with a definite group of mucous cells. Often secondarily green from an unknown cause.

Operculum: Muscle insertion area extensive, spiral sculpture absent. No internal ridge. Colour yellowish.

Radula: Central 3 + 1 + 3; lateral 1-2 + 1 + 2-3. Inner marginal with 4 denticles. Outer marginal typical, base very broad.

This subgenus has some features in common with *Dardanula* and *Cerostraca*. The size of the shell agrees with *Dardanula,* but the retracted aperture, some features of the animal, the operculum and the radula are all rather similar to *Cerostraca*. *Abscindostoma* differs from *Cerostraca* in the large shell, with no sign of a varix-like thickening behind the aperture, and the green colour of the animal. However, despite its apparent close similarity to *Cerostraca*, *Abscindostoma* appears to be a natural group, worthy of subgeneric distinction.

Eatoniella (Abscindostoma) lutea (Suter). Pl. 9, figs. 11-14.

1908 *Rissoina olivacea* var *lutea* Suter, Proc. Mal. Soc. 8, p. 33.
1913 *Rissoina* (*Eatoniella*) *olivacea* var *lutea* Suter; Suter, Man. N.Z. Moll. p. 226.
1915 *Dardanula olivacea* var *lutea* Suter; Iredale, Trans. N.Z. Inst. 47, p. 454.
1937 *Dardanula olivacea lutea* Suter; Powell, Shellfish of N.Z. p. 70.

This species has previously been classified as a variety of *E. olivacea* (Hutton) and, later, as a subspecies. The two species are, in fact, very distinct.

The shell of *E. lutea* is rather large for the genus, of light build and generally of pale colour. Yellowish-white, pinkish, orange-pink, grey green and dark grey specimens are encountered but usually in a given locality only one or two intergrading colour forms are found. In some areas shells showing a sutural and peripheral series of small pale blotches are encountered. The whorls are faintly convex and the periphery rounded. The outer lip is characteristic in being strongly and evenly retracted basally and the peristome is only slightly thickened.

The large size, light build, pale coloration, and strongly retracted outer lip, make this species distinctive. The darker colour forms approach *E. albocolumella* n. sp., but the two species are distinguishable on the basal coloration, as the presence of a sharply defined white zone in the region of the umbilicus and columella in *E. albocolumella,* is in sharp contrast to the uniform coloration of this region in *E. lutea*.

Animal: (Takapuna, Auckland). (Fig. 12). Cephalic tentacles long, active, with faint, very minute pustules on their surface. Eyes large, in swellings on outer bases of tentacles. Foot long, rounded anteriorly, slightly constricted behind anterior edge, posterior end rounded. Posterior pedal mucous gland large, white, opening into an open slit which extends from centre of foot to posterior end. Sole ciliated, cilia long on anterior edge, beat in posterior direction. Snout short, bilobed. Colour greenish-grey, sole yellowish-white, opercular lobe dark green-grey; buccal mass normally red but often invaded by green pigment, wholly or partially, giving it a bright green colour. One opercular tentacle on left opercular lobe, a patch of large mucous cells on right opercular lobe.

The green coloration of the animal is possibly due to ingested chlorophyll pigment that has been stored in the integument or, perhaps, to an algal symbiont.

Operculum: (Fig. 13). Oval, curved, thickened, yellow, with no obvious spiral sculpture or internal ridge. Peg short, stout and grooved. Marginal area well defined. Muscle insertion area extensive, occupying most of operculum, bordered on columella side by a weak, raised, ridge. Weak growth lines visible.

Radula: (Fig. 14). Typical of genus. Central 3 + 1 + 3, lateral 2 + 1 + 2, inner marginal 2 + 1 + 1, the third a rather large cusp; outer marginal with about six fine serrations.

Lectotype: Maloney's Reef, Auckland (G.S.).

Type Specimens: Height 2.5-2.7 mm. Width 1.4-1.5 mm. (from Suter).

Paralectotype: (Fig. 11). Height 2.53 mm. Width 1.36 mm.

Material Examined:

Paralectotypes; Cape Maria van Dieman, shell sand (W.F.P.); Takapau Kura, Spirits Bay, algae (Powell Coll.); Spirits Bay, shell sand (Hipkins Coll.); Doubtless Bay, Finlay Coll. (A.M.); Whangaroa Harbour, algae (Hipkins Coll.); Cavalli Islands, off Whangaroa, algae, -/6/52 (D.M.); Taupo Bay, Whangaroa, shell sand, E. R. Richardson, 11/4/51 (D.M.) and 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, Dell Coll. (D.M.) and -/1/52 (Hipkins Coll.); Whangaruru, shell sand, 16/2/56 (W.F.P.); Smuggler's Bay, Whangarei Heads, algae, 16/5/62 (W.F.P.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.) and algae, 22/5/63 (W.F.P.); Tryphena, Great Barrier Island, -/1/51 (Hipkins Coll.); Goat Island Bay, Leigh, brown algae, 1963-64 (W.F.P.); Tawharanui Point, *Cystophora,* 31/12/63 (W.F.P.); Waiwera, *Carpophyllum* spp., 16/2/64 (W.F.P.); Motutapu Island (Powell Coll.); Takapuna, Auckland, Finlay Coll. (A.M.); Takapuna reef, *Carpophyllum* spp., 1962-64 (W.F.P.); Brown's Bay, Auckland, brown algae, 19/1/64 (W.F.P.); Narrow Neck Reef, Auckland, brown algae on exposed side, 1962-64 (W.F.P.); Jackson's Bay, Coromandel, *Carpophyllum plumosum,* 19/3/64 (W.F.P.); Stony Bay, Coromandel, large brown algae, 28/3/64 (W.F.P.); Sandy Bay, Coromandel, large brown algae, 30/3/64 (W.F.P.); Cape Runaway, algae, A. W. B. Powell, -/8/33 (Powell Coll.); Tolaga Bay, R. K. Dell, 28/11/50 (D.M.); Gisborne, shell sand, 1906 (D.M.); Lyall Bay, Finlay Coll. (A.M.); Breaker Bay, Wellington, Finlay Coll. (A.M.); Island Bay, Wellington, brown algae, *Caulerpa, Corallina,* 28/2/59 and 3/6/62 (W.F.P.); Island Bay, Finlay Coll. (A.M.); Titahi Bay, 1905 (D.M.); Karehana Bay, Plimmerton, *Carpophyllum Xiphophora,* 7/12/61 (W.F.P.); between Pukerua and Paekakariki, brown algae, 24/12/61 (W.F.P.); Sharks Tooth Reef, Kaikoura, fine brown algae, P. Luckens, 12/8/64 (W.F.P.); Taylor's Mistake, Bank's Peninsula, *Cystophora* in pools, W. R. B. Oliver, 10/4/10 (D.M.); East of Diamond Harbour, Lyttelton Harbour, brown algae, *Corallina,* -/9/63 (W.F.P.); Lyttelton, H. Suter (D.M.); East of Purau, Lyttelton Harbour, fine brown weed, coralline algae, W. R. B. Oliver, 4/9/10 (D.M.); Chatham Island Exped., Port Hutt, Chatham Island, 8/2/54 (D.M.).

Distribution: The East Coast of the North Island, the Wellington West Coast, and the North East of the South Island, on large clean algae on exposed coasts. The single record from the Chatham Islands needs confirmation.

Ecology: *E.* (*A.*) *lutea* is abundant only on large brown algae such as species of *Carpophyllum,* though it also occurs on short algae such as *Corallina,* possibly by accidental colonisation by wave dislodged individuals. At Takapuna and Narrow Neck, Auckland, where conditions

ranging from a fairly exposed rock face to a silted, sheltered pool or channel, occur within a few yards, an interesting gradation of frequency of occurrence can be seen in *E. lutea*. In the most exposed situations it is common and dominant, occurring with a large form of *E.* (*D.*) *olivacea* (Hutton), but it is usually replaced by *E.* (*D.*) *varicolor* n. sp., which it superficially resembles, in the low tidal pools and fairly sheltered channels. In very sheltered situations it is altogether absent, while *E.* (*D.*) *olivacea* and *E.* (*D.*) *limbata* (Hutton) are common, the latter being dominant in the most sheltered and silted places.

Eatoniella (Abscindostoma) albocolumella n. sp. Pl. 9, figs. 15-18.

Shell small, thin, semi-transparent, smooth, shining, imperforate variably coloured. Spire tall, conical, with straight outlines; whorls 5, lightly convex, false margined; protoconch moderately large, smooth, of similar colour to spire whorls, not distinctly marked off; body whorl with a rounded periphery and base. Aperture moderately large, oval; peristome continuous, weakly thickened; outer lip sharp, thickened a little posteriorly and internally, strongly and broadly excavated. Inner lip evenly concave and produced a little below. A narrow groove in umbilical region, but no umbilicus. Colour variable, usually dark purplish grey, sometimes uniform as in the holotype, except for the lower part of the base and columella which are always white. Usually with a series of irregular white blotches below sutures and/or on periphery, these frequently becoming broadly developed as irregular white zigzag markings. There is great variation within populations, all intergradations between nearly pure white shells and uniform dark shells occur.

The species superficially resembles *E.* (*D.*) *limbata* (Hutton), but is easily separated from it by the thin shell, strongly reflected outer lip, more irregular markings and white umbilical region.

Animal: (Piha, Leigh). (Fig. 16). Cephalic tentacles long, very mobile, tapering, colourless, transparent, eyes on swellings on outer bases of tentacles and situated beneath transparent edge of shell. Snout short, bilobed, dorsally and terminally yellowish, sides black. Buccal mass orange. Posterior dorsal and lateral parts of head, sides of foot and opercular lobe black, amount of pigmentation varying. Foot moderately long, with a slit extending from middle region of sole to posterior end, and surrounding this is the dense-white posterior mucous gland. Parts of dorsal side of foot and snout are sometimes green. A short opercular tentacle, smudged with black, on left opercular lobe, a group of white gland cells on right lobe.

Operculum: (Fig. 17). Oval, yellow, curved. Marginal areas rather narrow, columella side broader. Peg stout, grooved. No internal ridge or thickening. Muscle insertion area dense yellow-white, extensive.

Radula: (Fig. 18). Central large 3 + 1 + 3, lateral, 1 + 1 + 3, with a dorsal thickening, elongate. Inner marginal with 3 main denticles and a very small cusp-like process on outer side. Outer marginal with a broad base and finely serrate.

Holotype: (Fig. 15). Cape Campbell, coralline algae, 16/2/64, Coll. W. Ballantine (A.M.). Height 2.37 mm. Width 1.35 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; 4 fathoms between Cape Maria van Diemen and mainland, -/2/61 (Hipkins Coll.); Spirits Bay, shell sand (Hipkins Coll.); Takapau Kura, Spirits Bay, algae, A. W. B. Powell, -/2/32 (Powell Coll.); Tom Bowling Bay, -/1/54 (Gardner Coll.); 12 fathoms, Doubtless Bay, Finlay Coll. (A.M.); Doubtless Bay, E. A. Brookes, Oliver Coll. (D.M.); Waiau Beach, Mangonui, E. R. Richardson, 11/4/51 (D.M.); MacGregor's Bay, Whangarei Heads, algae, 22/5/63 (W.F.P.); Ocean Beach, Whangarei Heads, algae, 7/5/62 (W.F.P.); Smugglers' Bay, Whangarei Heads, *Carpophyllum plumosum*, 6/5/62 (W.F.P.); Bream Tail, 12/8/63, under stones, small algae, *Carpophyllum* spp., 12/8/63 (W.F.P.); Laings Beach, Mangawai, shell sand (Hipkins Coll.); Goat Island Bay, Leigh, under stones, brown algae, *Corallina* (W.F.P.); Tawharanui Point, North side, under stones on papa platform, 31/12/63 (W.F.P.); Okupu, Great Barrier Island, *Carpophyllum*, under stones, -/11/63 (W.F.P.); Kaitoke, Great Barrier, *Corallina*, short soft algae, 16/11/63 (W.F.P.); Motutapu Island, Auckland, Dell Coll. (D.M.); Narrow Neck Reef, Auckland, *Carpophyllum plumosum*, 26/3/63 (W.F.P.); southern end of Muriwai, *Corallina* in pool, under stones, 19/8/63 (W.F.P.); Piha, various algae, 1963-64 (W.F.P.); Jackson's Bay, Coromandel, *Carpophyllum plumosum*, 29/3/64 (W.F.P.); Stony Bay, Coromandel, brown algae, 28/3/64 (W.F.P.); Sandy Bay, Coromandel, brown algae, 30/3/64 (W.F.P.); Waihi, *Corallina* (W.F.P.); off Mayor Island, in fish stomach contents, G. Williams (Powell Coll.); Cape Runaway, algae, A. W. B. Powell, -/8/33 (Powell Coll.); Gisborne, shell sand, 1906 (D.M.); Castle Point, algae, J. E. Morton, -/3/63 (W.F.P.); Day's Bay, Wellington Harbour, brown algae, 11/12/61 (W.F.P.); Lyall Bay (A.M., D.M.); Owhiro Bay, Wellington, *Corallina*, 20/2/63 (W.F.P.); Oaro, South of Kaikoura, coralline algae, W. Ballantine, 19/2/64 (W.F.P.); Taylor's Mistake, Bank's Peninsula, coralline algae, -/8/63 (W.F.P.).

Distribution: North Island, North East of South Island and Chatham Islands, typically on exposed coasts.

Ecology: This species is often abundant in coralline algae and short turf algae on exposed coasts, but it is also found, to a lesser extent, under stones and on coralline and brown algae on coasts of moderate exposure.

Subgenus **Albitoniella** n. subgen.

Type: *Dardanula pallida* Powell, 1937.

Shell: Similar to *Dardanula,* but of rather lighter build. Colour pale yellowish.

Animal: Details unknown.

Operculum: Muscle insertion area extensive. Colour yellowish. No internal ridge.

Radula: As described for *E.* (*A.*) *pallida.* The features of the radula sharply separate *Albitoniella* from the other subgenera of *Eatoniella.*

Eatoniella (Albitoniella) pallida (Powell). **Pl. 6., figs. 16-18.**

1936 *Dardanula pallida* Powell, Discov. Rep. 15, p. 203, pl. 53, fig. 16.

Shell small, thin, smooth, shining, elongate-conical. Whorls 4½, faintly convex, false margined, with fine growth lines and subobsolete spiral scratches; protoconch smooth, dome-shaped, not clearly marked off; periphery subangled, base convex. Aperture oval, peristome thin, continuous; inner lip slightly thickened; outer lip thin, sharp, retracted, bent downwards and produced forward posteriorly. A tiny chink in position of umbilicus sometimes continued as a shallow, narrow, groove separating body whorl and inner lip. No true umbilicus. Colour yellow-

ish-brown, colourless and transparent just behind aperture, and bordering this behind, is a narrow pure white strip. Variation in size, relative width, and density of colour.

Animal: (Off Three Kings Islands). Appears to be typical of family. Unpigmented except for proximal half of snout and edges of opercular lobes, which are dark grey. Eyes large, at bases of long, colourless tentacles. (Preserved material).

Operculum: (Fig. 17). Ear shaped, pale yellowish, slightly curved, muscle insertion area extensive, opaque; marginal areas narrow and transparent. Peg long, curved, grooved. Very faint spirals and growth lines visible.

Radula: (Fig. 18). Central large, typical of the genus, 3 + 1 + 3. Lateral large, rather short, with very small cusps, 3 + 1 + 5, with dorsal and ventral thickenings. Inner marginal atypical of genus, a simple curve, distally pointed, basally thickened; outer marginal long, distally pointed and curved, basal portion relatively narrower than in other eatoniellids.

Holotype: Discovery II Stat. 933, off Three King Islands, in 260 metres (British Museum).

Height 1.65 mm. Width 1.05 mm. (from Powell).

Material Examined:

Paratypes (Powell Coll.); N.Z.O.I. Stat. C.760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.); off Mayor Island, in fish stomach contents, G. Williams (Powell Coll.)).

Distribution: Off the North and North East of the North Island, in moderately deep water, probably restricted to bryozoan substrates.

Eatoniella (Albitoniella) thola n. sp. **Plate 6, fig. 19.**

Shell small, smooth, shining, with a blunt protoconch. Whorls 3½, lightly convex, false margined, thin, transparent, protoconch large, bluntly dome-shaped, smooth, not distinctly marked off; body whorl large, periphery and base rounded. Aperture large, round, peristome continuous, weakly thickened; inner lip spread over body whorl as a thin layer; columella weakly thickened, vertical; a narrow chink behind columella but no umbilicus; outer lip excavated below, dilated, bent downwards slightly posteriorly, a transparent narrow zone behind. Colour pale yellowish, a narrow white band below periphery and umbilical region.

There is some variation in the height of the spire and the bluntness of the protoconch.

Animal, radula and operculum unknown.

Holotype: (Fig. 19). N.Z.O.I. Stat. C.760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, 18/2/62 (O.I.).

Height 0.95 mm. Width 1.25 mm.

Paratypes: Auckland and Dominion Museums, N.Z. Geological Survey, Lower Hutt, N.Z. Oceanographic Institute.

Material Examined: Holotype and paratypes.

Distribution: In moderately deep water off the Three Kings Islands.

This species is only tentatively placed in *Albitoniella* with which it agrees, fairly closely, on shell characters.

Subgenus **Albosabula** n. subgen.

Type: *Rissoa lampra* Suter, 1908.

Shell: Small, white, outer lip a little retracted.

Animal: Details unknown.

Operculum: Muscle insertion area extensive. Yellowish-white.

Radula: As described for *E.* (*A.*) *lampra.* The most characteristic feature is the inner marginal which has 6-9 small denticles and is nearly straight, not curved or S-shaped as in other subgenera.

Eatoniella (Albosabula) lampra (Suter). Plate 10, figs. 6-9.

1908 *Rissoa lampra* Suter, Proc. Mal. Soc. Lond., 8, p. 29, pl. 2, fig. 25.
1913 *Rissoa* (*Cingula*) *lampra,* Suter; Suter, Man. N.Z. Moll. p. 208, pl. 12, fig. 15.
1915 *Estea lampra* (Suter); Iredale, Trans. N.Z. Inst., 47, p. 454.
1933 *Notosetia lampra* (Suter); Powell, Rec. Auck. Inst. Mus., 1 (4), p. 198, pl. 34, fig. 7.
1962 *Notosetia lampra* (Suter); Smith, (in part), Rec. Dom. Mus., 4 (5), p. 54.

Smith (1962) has described and figured a shell from Stewart Island which she thought was the local form of *E.* (*A.*) *lampra,* but here it is considered to be a separate species. *E.* (*A.*) *lampra* is also found at Stewart Island and the two species are distinguishable on minor characters. A description of a typical shell from Stewart Island is given below.

Shell small, solid, opaque. Spire tall, whorls 4½ to 5, flat, with a faint depression below a weak subsutural swelling on body whorl; body whorl not swollen. Aperture oval, with a distinct posterior angle; peristome thickened; inner lip thickened, oblique, straight above, curved anteriorly, distinct, but not separated from body whorl by a groove. Outer lip nearly straight, suddenly bent downwards posteriorly, thickened in this portion and below, while a very shallow, small, false sinus, formed by partial retraction of outer lip which straightens below. No varix-like thickening behind outer lip. Colour yellowish-white, often coated with brown.

Animal: (Kaikoura). Tentacles long, eyes at their outer bases. Snout bilobed, rather long. Colour yellowish white. (Preserved specimen).

Operculum: (Fig. 8). Oval, slightly curved, muscle insertion area semi-opaque, extensive, marginal areas rather narrow, transparent. Colour yellowish, muscle insertion area yellowish-white. Peg strong, short, rather broad, grooved. Growth lines very weak.

Radula: (Fig. 9). Typical of genus, ribbon long, narrow, teeth small. Central relatively large, 2 + 1 + 2, lateral 3 + 1 + 3, elongate. Inner marginal nearly straight, with about 6 small denticles, outer-most largest. Outer marginal finely serrate, base wide.

Lectotype: Titahi Bay, Cook Strait (G.S.).

Height 1.5 mm. Width 0.8 mm. (from Suter).

Paralectotype: (Fig. 6). Height 1.1 mm. Width 0.625 mm.

Material Examined:

Paralectotypes; Makara, Wellington, M. Mestayer, 26/8/36 (D.M.); Karaka Bay, Wellington, under stones on gravel bank, R. K. Dell, 6/2/48 (D.M.); Island Bay, Wellington, 3/6/62 (W.F.P.); Shark's Tooth Reef, Kaikoura, under stones, embedded in shell sand, P. Luckens, 12/8/64 (W.F.P.); East of Diamond Harbour, Lyttelton Harbour, under stones, -/8/63 (W.F.P.); Groper Island, near Bravo Island, Paterson Inlet, Stewart Island, algae, 1/7/53 (Smith Coll.); Ruggedy, Stewart Island, 25 fathoms, on bryozoans, 4/11/56 (Smith Coll.); Butterfield's Beach, Stewart Island, O. Allan, -/10/47 (D.M.); Aker's Point, Halfmoon Bay, Stewart Island, under stones, M. Spong, 22/2/63 (W.F.P.); 10 fathoms, off Owenga, Chatham Islands, A. W. Powell, -/2/33 (A.M.).

Distribution: The southern portion of the North Island, the East Coast of the South Island, Stewart Island and the Chatham Islands. In the lower littoral zone, this species lives underneath stones.

Eatoniella (Albosabula) poutama (Smith). Plate 10, fig. 11.

1962 *Zeradina poutama* Smith, Rec. Dom. Mus., 4 (5), p. 62, fig. 4.

E. (*A.*) *poutama* is closely allied to *E.* (*A.*) *rakiura* n. sp., but also superficially resembles *E.* (*D.*) *dilatata* (Powell). The shell is a little larger than *rakiura* and *E.* (*A.*) *lampra* (Suter), and is redescribed below for comparison.

Shell semi-transparent, smooth, white, thin but not fragile, periphery and base rounded, body whorl swollen. Whorls 4-4½, convex, false margined; body whorl large. Aperture thickened, oval, slightly angled above; inner lip thickened, concave, separated from body whorl by a narrow but distinct, groove. Outer lip a little bent downwards posteriorly, with a weak false sinus similar to that of *E.* (*A.*) *lampra.* Animal, operculum and radula unknown.*

Smith describes the exterior of the operculum as having "numerous radiating wrinkles spreading from a point below the middle of the inner margin."

Holotype: Off Poutama Island, South Cape, Stewart Island, 30 fathoms, in bryozoan shell sand, W. Hopkins (D.M.).

Height 1.44 mm. Width 0.88 mm.

Material Examined:

Paratypes (A.M.); Doubtful Sound, 50 fathoms (W.F.P.); Snares Islands, 50 fathoms, Finlay Coll. (A.M. and D.M.); 85 fathoms, Auckland Islands, Finlay Coll. (A.M.).

Distribution: Fiordland, Stewart Island, and the Snares and Auckland Islands. Smith (1962) records this species living under stones embedded in muddy sand at Stewart Island (Horseshoe Bay and Halfmoon Bay).

Smith has included this species in *Zeradina,* but the shell, in most features, is unlike the fossarids, while it is clearly related to the *E. lampra* group.

Note—Since the above was written, the author has examined specimens of *E. (A.) poutama,* which have typical eatoniellid operculae.

Eatoniella (Albosabula) rakiura n.sp. Plate 10, fig. 10.

1962 *Notosetia lampra* (Suter), Smith (in part) Rec. Dom. Mus. 4 (5), p. 54, fig. 10.

The shell is similar to E. (*A.*) *lampra* (Suter), but differs from that species in its more swollen, weakly convex, false margined whorls which number 4. Shell semi-transparent, fragile; aperture oval, the posterior angulation less marked than in *lampra;* peristome a little thickened; inner lip angled in central part, outer lip straighter and the posterior bent portion not as marked as in *lampra,* the false sinus just discernible.

The main distinguishing points are the thin shell and the evenly convex, swollen whorls.

Animal: Unpigmented, (preserved material).

Operculum: Very similar to that of *E.* (*A.*) *lampra.* Oval, but a little flattened on left end, insertion area similar in extent to *E.* (*A.*) *lampra,* but marginal areas a little wider. Peg short, stout, grooved. Colour yellowish, muscle insertion area yellowish-white, opaque, rest of operculum transparent. A few faint spiral striae visible.

Radula: Similar to that of *E.* (*A.*) *lampra* but the inner marginal has more denticulations, there being about 9, all of similar size.

Holotype: (Fig. 10). Ruggedy, Stewart Island, 25 fathoms on bryozoan, 4/11/56 (ex Smith Coll.) (A.M.).

Height 1.1 mm. Width 0.65 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt, E. Smith Coll.

Material Examined:

Holotype and paratypes; Butterfield's Beach, Stewart Island, O. Allan, -/10/47 (D.M.); Groper Island, near Bravo Island, Patterson Inlet, Stewart Island, algae, 1/7/53 (Smith Coll.).

Distribution: Stewart Island.

Subgenus **Caveatoniella** n. subgen.

Type: *E.* (*C.*) *puniceomacer* n. sp.

Shell: Small, ovate, thin, widely umbilicate. Whorls strongly convex. Peristome thin, inner lip separated from body whorl.

Animal: No opercular tentacles.

Operculum: Muscle insertion area extensive. Colour white.

Radula: As described for *E.* (*C.*) *puniceomacer* n. sp.

Eatoniella (Caveatoniella) puniceomacer n. sp. Pl. 10, figs. 16-18

Shell minute, thin, semi-transparent, pink, rather loosely coiled, with a wide umbilicus. Whorls $3\frac{1}{2}$, strongly convex, a little flattened on shoulder, protoconch rather flattened. Spire variable in height, the shoulder not present in tall shells, but flattened and cut in at sutures in squat shells (holotype intermediate). Sutures false margined. Sculpture of growth lines only, becoming prominent around the large, deep,

circular umbilicus. Aperture oval, peristome continuous, nearly completely separated from body whorl, only slightly thickened. The outer lip is not retracted. Colour uniform pale pink, protoconch white. Fresh shells are purplish-black owing to the colour of the visceral mass.

Animal: (Taurikura Bay). Cephalic tentacles long, not tapering, bluntly pointed, colourless, eyes at outer bases of tentacles. Snout short, bilobed. Foot with a mucous slit in posterior half. No opercular tentacles. Eyes and snout remain beneath transparent edge of shell.

Operculum: (Off Mayor Island) (Fig. 17). Thickened, slightly curved, muscle insertion area opaque, extensive, marginal area rather narrow and clear. Peg rather long and narrow, solid, white. Sculptured with faint spirals and weak growth lines.

Radula: (Fig. 18). Central rather small for genus, with two very strong basal processes, cusps 1 + 1 + 1, central cusp strong. Lateral 1 + 1 + 2, the cusp small. Inner marginal with 5 moderately strong denticles; outer marginal finely serrate, with broad basal portion.

Holotype: (Fig. 16). Tryphena Bay, Great Barrier Island, in shell sand (ex Hipkins Coll.) (A.M.).

Height 0.95 mm. Width 0.73 mm.

Paratypes: Auckland Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt, N.Z. Oceanographic Institute, and K. Hipkins Collection.

Material Examined:

Holotype and paratypes; Spirits Bay, shell sand, (Hipkins Coll.); Taupo Bay, Bay, 12 fathoms, W. LaRoche (Powell Coll.) and Oliver Coll. (D.M.); 10 fathoms, Awanui Bay, Finlay Coll. (D.M.); Taupo Bay, Whangaroa, 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); Taurikura Bay, Whangarei Heads, shallow channel in coarse sand, 18/5/61 (W.F.P.); Great Barrier Island, 8-10 fathoms, Dell Coll. (D.M.); off Otata Islands, Noises Group, Hauraki Gulf, 4 fathoms, coarse sand, 15/5/63 (W.F.P.); off Mayor Island in fish stomach contents, G. Williams (Powell Coll.).

Distribution: The North East of the North Island in shallow water.

Eatoniella (Caveatoniella) perforata n. sp. Plate 10, fig. 19.

Shell small, white, ovate conic, umbilicate. Whorls 4½, moderately convex, false margined, smooth and polished, except for growth lines and faint spiral scratches; protoconch dome-shaped, smooth, depressed, not marked off. Body whorl swollen, periphery and base convex. Aperture ovate, distinctly angled above. Peristome thin except where inner lip attached to body whorl, where it is somewhat thickened, the thickened edge sharply separate from body whorl. Columella portion of inner lip thin, separated from base by umbilicus. Outer lip straight, thin. Umbilicus rather wide, deep, strong growth lines in groove below.

Animal, operculum and radula unknown.

Holotype: Doubtless Bay, 12 fathoms, Coll. W. LaRoche, ex Finlay Coll. (A.M.).

Height 1.25 mm. Width 0.83 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt, N.Z. Oceanographic Institute.

Material Examined:

Holotype and paratypes; off Hen and Chickens Islands, Finlay Coll. (A.M.).

Distribution: The North East of the North Island in moderately deep water.

Subgenus **Cerostraca** Oliver, 1915.

Type (o.d.): *C. iredalei* Oliver, 1915.

The most distinctive features of the Kermadec Island *E.* (*C.*) *iredalei* (Oliver) (Pl. 9, figs. 1, 1a) are the detached aperture and the varix-like callosity behind the outer lip. These features are also seen, but to a lesser degree, in a new species from New Zealand, *E.* (*C.*) *delli*, described below. This species closely resembles another new species, *E.* (*C.*) *maculosa*, which has only a suggestion of the apertural features seen in *E.* (*C.*) *iredalei*, yet it is clearly closely allied. *Dardanula tenella* Powell, from off the Three Kings resembles the last mentioned new species, but has little in common with *E.* (*C.*) *iredalei*. A third new species from the South Island and Stewart Island, *E.* (*C.*) *bathami*, closely resembles *E.* (*C.*) *delli* n. sp. and *E.* (*C.*) *maculosa* n. sp. in radula and opercular characters and the shell is not discordant with a new conception of *Cerostraca*. The group as a whole is closely allied to the *Eatoniella-Dardanula* group of species but can be distinguished by the following characteristics:

Shell, thin, small, conical; periphery subangled or rounded. Aperture oval, peristome thin, outer lip depressed suddenly posteriorly and retracted below this portion, rest of lip nearly straight, simple, thin. At point of depression behind outer lip there is a swelling, which may be strong forming a varix-like structure, or weak and hardly noticeable. Colour dark or pale with dark spots.

Species of this subgenus can be distinguished from *Dardanula* by their characteristic thin shells, weakly thickened peristome and apertural features.

Animal: Similar to that of some *Dardanula* species in having a single right opercular tentacle, but there is a distinct, small, group of white gland cells on the left lobe as seen in *Abscindostoma* and *Pellax*.

Operculum: Oval, yellow, muscle insertion area extensive, no internal ridge, peg short and solid. Colour yellowish.

Radula: Shape of teeth typical. Central 3 + 1 + 3, lateral 2 + 1 + 3, inner marginal 3 + 1 + 1, outer marginal finely serrate.

Eatoniella (Cerostraca) bathami n. sp. Plate 9, figs 9, 10.

Shell, small, conical, rather large for subgenus, moderately solid, smooth, shining, variable in colour. The spire with 4 weakly convex whorls; protoconch smooth, not marked off; sutures weakly incised, false margined; body whorl large, periphery slightly angled, base convex. Surface smooth except for faint growth lines, also a few very faint spiral scratches visible. Aperture large, rounded, slightly angled above, peristome thickened. Outer lip excavated below, produced forward

posteriorly where it is bent downwards. A slight swelling just behind outer lip and in the upper quarter of whorl, is only indication of characteristic varix-like thickening of subgenus. Columella moderately thick, concave, inner lip partly covering a small umbilical chink. Colour variable, usually dark greyish-purple to pale grey or yellowish white. Holotype pale greyish with a purple tinge. A diffuse white band below the periphery is often present and, in the holotype, is visible on the body whorl. Body whorl usually paler in colour than rest of shell, and a distinct white patch around umbilical area.

Specimens vary considerably in colour, size and shape. Small shells are usually broad, large shells often narrow. In some populations most shells are white (e.g. in algae, Halfmoon Bay, Stewart Island), while in others there are no white individuals (e.g. type series).

Animal: (Halfmoon Bay, Stewart Island). External parts unpigmented (preserved material).

Operculum: (Fig. 10). Oval, slightly curved, yellowish-white, growth lines hardly visible, marginal areas narrow. Peg short, wide. Muscle insertion area extensive, dense.

Radula: Very similar to that of *E.* (*C.*) *delli*. Central 3 + 1 + 3, the outermost cusp very minute. Lateral 2 + 1 + 3; inner marginal 3 + 1, the outermost denticle largest. Outer marginal finely serrate.

Holotype: (Fig. 9). Little Papanui, Dunedin, on gelatinous red algae, 5/9/63, W.F.P. (A.M.).

Height 1.42 mm. Width 0.8 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Taylor's Mistake., Bank's Peninsula, coralline algae, -/8/63 (W.F.P.); Little Papanui, Dunedin, coralline algae, under stones, 5/9/63 (W.F.P.); Taieri Beach, Otago, algae, Finlay Coll. (A.M.); Halfmoon Bay, Stewart Island, algae, E. Smith, 12/6/52 (W.F.P.); 8 fathoms off mouth of Halfmoon Bay, Stewart Island, clean algae, -/4/59 (Smith Coll.); Harolds Point, Stewart Island, algae, 18/9/56 (Smith Coll.); Ringaringa, Nugget Point, Stewart Island, algae (Smith Coll.).

Distribution: The East Coast of the South Island and Stewart Island, living on algae.

This species is named after Dr E. J. Batham, in appreciation of her kindness and valuable assistance during my stay at the Portobello Marine Biological Station.

Eatoniella (Cerostraca) delli n. sp. Plate 9, figs. 2-6.

Shell minute, dark purplish, conical, smooth. Whorls 4½, slightly convex, sutures moderately impressed. Protoconch smooth, not marked off. Sutures false-margined by a dark band. Body whorl subangled at periphery, base flatly convex. Colour purplish, the protoconch pale yellow, semi-transparent, aperture grey. Aperture oval, angled anteriorly and posteriorly; columella strongly concave; umbilical chink very small; outer lip much retracted, bent forwards posteriorly and reflected at edge. A weak, varix-like swelling a little behind outer lip.

E. (*C.*) *delli* differs from the type species (Pl. 7, fig. 1, 1a) by its shorter spire, larger aperture and weaker 'varix'. Shells show considerable variation in size, shape (c.f. figs. 2 and 3) and colour and it is possible that they belong to more than one species. Shells with white markings are sometimes encountered.

Animal: (Fig. 4). (Leigh). Cephalic tentacles colourless, long, active. Snout bilobed, short, black on sides and dorsally; buccal mass yellow, showing through integument. Eyes rather small, on slight swellings, at bases of tentacles and visible beneath transparent edge of shell. Opercular lobe black, with or without a short tentacle on left side, with a small group of mucous cells on right side. Foot long, bluntly rounded anteriorly, with a small anterior mucous gland. Posterior mucous gland large, opening into a long slit extending from middle of sole to posterior end.

Operculum: (Fig. 5). Thickened, slightly curved, yellowish. Muscle insertion area extensive, opaque, columella edge a raised rim. Peg short and solid. Marginal area is moderately wide. Faint growth lines are the only sculpture.

Radula: (Fig. 6). Typical of the genus. Central 3 + 1 + 3, lateral 2 + 1 + 3, with a strong basal thickening and a weaker dorsal rib. Inner marginal 3 + 1 + 1, the denticles of similar size, though fourth a little larger; outer marginal with fine serrations.

Holotype: (Figs. 2, 2a). Bream Tail, in Corallina (W.F.P.), 21/8/63 (A.M.).

Height 1.24 mm. Width 0.73 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; North Cape, small algae, W. R. B. Oliver, 26/11/16 (D.M.); Spirits Bay, algae, W. R. B. Oliver, 1889 (D.M.) and shell sand (Hipkins Coll.); Taupo Bay, Whangaroa, E. R. Richardson, 11/4/51 (D.M.); and 2/1/54 (Hipkins Coll.); Cavalli Islands, Whangaroa, algae, -/6/52 (D.M.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.) and algae, 22/5/63 (W.F.P.); Smuggler's Bay, Whangarei Heads, *Carpophyllum plumosum*, 6/5/62 (W.F.P.); Ocean Beach, Whangarei Heads, red algae, 7/5/62 (W.F.P.); Poor Knights Islands, under vermetid masses, coralline algae and brown algae, 4/4/64 (W.F.P.); Bream Tail, under stones, *Carpophyllum* spp., 12/8/63 (W.F.P.); Goat Island Bay, Leigh, under stones, *Corallina*, various algae, 1962-64 (W.F.P.); Tryphena Bay, Great Barrier Island, -/1/51 (Hipkins Coll.); Kaitoke, Great Barrier Island, coralline algae and short algae, 16/11/63 (W.F.P.); Okupu, Great Barrier Island, *Corallina*, fine brown algae in pool, -/11/63 (W.F.P.) Takapuna, Auckland, *Corallina*, brown algae, 1962-64 (W.F.P.); Muriwai, under stones, coralline algae, 19/8/63 (W.F.P.); Piha, various algae, 1962-63 (W.F.P.); 1 mile West of Cornwallis, Manukau Harbour, brown algae, clean coralline algae, 7/1/62 (W.F.P.); Jackson's Bay, Coromandel, under stones, fine red algae, 2/3/64 (W.F.P.); Sandy Bay, Coromandel, *Corallina*, 30/3/64 (W.F.P.); Stony Bay, Coromandel, *Corallina*, other small algae, 28/3/64 (W.F.P.); Tolaga Bay, shell sand, R. K. Dell, 28/11/50 (D.M.); Day's Bay, Wellington Harbour, 11/12/61 (W.F.P.); Lyall Bay, Wellington, *Cystophora*, W. R. B. Oliver, 18/12/21 (D.M.); Island Bay, Wellington, *Corallina*, *Caulerpa*, brown algae, 3/6/62 (W.F.P.); Owhiro Bay, Wellington, *Corallina*, brown algae, 6/5/62 (W.F.P.); Titahi Bay, *Corallina*, 5/6/62 (W.F.P.); Karehara Bay, Plimmerton, *Xiphophora*, 7/12/61 (W.F.P.); Kaikoura, fine brown algae, P. Luckens, 12/8/64 (W.F.P.); Taylor's Mistake, Bank's Peninsula, coralline algae, W. R. B. Oliver, 10/4/10 (D.M.) and

coralline algae, -/8/63 (W.F.P.); East of Purau, Lyttelton Harbour, fine brown weed and fine coralline algae in pools, W. R. B. Oliver, 4/9/10 (D.M.); Gollan's Bay, Lyttelton Harbour, rock pools, W. R. B. Oliver, 6/4/07 (D.M.); Okain's Bay, Bank's Peninsula, W. R. B. Oliver, 10/11/06 (D.M.).

Distribution: North Island and the North East of the South Island, at low tide.

Ecology: This minute species prefers finely divided algae in which to live, but is also found on large algae and under stones.

I have much pleasure in naming this species after Dr R. K. Dell in appreciation of his invaluable advice and assistance during the course of these investigations, and for his early patient tutoring and encouragement.

Eatoniella (Cerostraca) maculosa n. sp. Plate 9, fig. 7.

Shell similar to *E.* (*C.*) *delli* n. sp., but a little larger, with a more rounded periphery, generally broader shell, different coloration, and weaker varix. The colour varies from yellowish-brown to dark purplish-grey. In the holotype there is a dark purplish band below the sutures on the periphery, and on the middle part of the base. A row of irregular dark blotches, often alternating with small white blotches, replaces the band in many paratypes.

Also similar to *E.* (*C.*) *tenella* (Powell), the new species differs in its smaller size and variable colour pattern.

Animal: As in *E.* (*C.*) *delli* n. sp., but with more intensely black opercular lobes. Opercular tentacle short, on the left lobe, black, a distinct group of mucous cells on right lobe. Proximal end of the snout, dorsal part of head and anterio-dorsal part of foot, are black. Rest of exposed animal yellowish, sole white.

Operculum: Similar to that of *E.* (*C.*) *delli*. Yellowish, curved, semi-transparent, peg broad and flattened. Marginal areas narrow. Fine growth lines and subobsolete spirals present. Insertion area yellowish-white, rather dense.

Radula: Similar to that of *E.* (*C.*) *delli*. Central 3 + 1 + 3, the outermost cusp very small. Lateral 2 + 1 + 3, the outer cusp very small, inner marginal 3 + 1 + 1, outer marginal finely serrate.

Holotype: (Fig. 7). MacGregor's Bay, Whangarei Heads, on various algae, 22/5/63, W.F.P. (A.M.).

Height 1.48 mm. Width 0.875 mm.

Paratypes: Auckland and Dominion Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Big King, Three Kings Islands, sublittoral algae, A. Baker, (W.F.P.); Spirits Bay, shell sand (Hipkins Coll.); Ocean Beach, red algae, *Carpophyllum maschalocarpum*, various small algae, under stones, 9/4/55 (W.F.P.); MacGregor's Bay, shell sand, 9/4/55 (Hipkins Coll.); MacGregor's Bay, algae, J. Wakeman, -/8/62 (W.F.P.); Shoal Bay, Great Barrier Island, algae (Hipkins Coll.).

Distribution: The East Coast of the North Island, North of Whangarei, and Great Barrier Island, in exposed situations on algae.

The *Cerostraca* group is difficult because the species are very variable and hard to define, when material from a wide geographical range is considered. There are probably more than two common species in the North Island, *maculosa* being applied to relatively large shells, with or without a colour pattern, and *delli* to small shells that are usually black, but sometimes have white markings. This situation is almost certainly a simplification.

Eatoniella (Cerostraca) tenella (Powell). Plate 9, fig. 8.

1936 *Dardanula tenella* Powell, Discov. Rep. 15, p. 203, pl. 53, fig. 15.

This poorly known species is tentatively placed in *Cerostraca* by virtue of its thin shell, shape, apertural features and coloration. The shell is redescribed below to facilitate identification, and for comparison with related species.

Shell thin, shining, imperforate, with faint growth striae and very fine spiral scratches. Spire broadly conical, whorls $4\frac{1}{2}$, lightly convex, false margined; protoconch smooth, not marked off; periphery subangled. Aperture round, peristome thin, inner lip concave, separated from base below; outer lip sharp, bent down a little posteriorly, slightly flanged all round. Colour pale yellowish, yellowish-brown or pale pink, with dark reddish-brown or brown zig-zag markings over base and as spots below sutures, these alternating with pure white spots. Basal markings often break up into basal and peripheral series of spots. Colour pattern basically constant, though a little variable in detail.

Though related to *E.* (*C.*) *maculosa* n. sp., it is larger in size, proportionately broader, with a rather different, more constant, colour pattern.

Animal, operculum and radula unknown.

Holotype: Discovery II Stat. 934, off Three Kings Islands, 92 metres, (Brit. Mus.).

Height 2.1 mm. Width 1.3 mm. (from Powell)

Material Examined: Paratypes (A.M.); N.Z.O.I. Stat. C.760 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.).

Distribution: Off Three Kings Islands.

Subgenus **Dardaniopsis** n. subgen.

Type: *E.* (*D.*) *notalabia* n. sp.

Shell: Small, ovate-conical, thin, semi-transparent. Outer lip bisinuate. Colour variable.

Animal: Two opercular tentacles, one on each lobe.

Operculum: Muscle insertion area only in columella half of operculum, bordered on its outer edge by a ragged line. No internal ridge.

Radula: Central 2 - 3 + 1 + 2 - 3, lateral 2 + 1 + 2 - 3, inner marginal 4 - 7 denticles, outer marginal typical.

Eatoniella (Dardaniopsis) notalabia n. sp. Plate 8, figs. 1-4.

Shell, minute, ovate-conical, body whorl swollen, aperture large and bisinuate. Spire slightly convex, of $3\frac{1}{2}$ whorls; protoconch not marked off, smooth, semi-transparent. Adult whorls lightly convex, semi-transparent, purplish-brown in holotype, though colour varies from yellowish-brown to black; distinctly false margined. Base and periphery rounded. Peristome continuous, inner lip thin, outer lip strongly retracted, bisinuate, a notch in middle and anteriorly. Columella concave, a tiny, shallow, umbilical chink present. Peristome encircled with black, especially on the outer lip. There is some variation in size and colour.

The small size, notched, black-rimmed outer lip and thin, dark-coloured, semi-transparent shell make this species most distinctive.

Animal: (Leigh). (Fig. 2). Typical of the subgenus. Cephalic tentacles long, mobile, protruding from the notches in the outer lip of the shell. Eyes visible beneath transparent rim of the shell, in swellings on outer bases of the cephalic tentacles. Foot rather short, bluntly rounded anteriorly. Anterior mucous gland poorly defined but posterior large and opens into a slit which extends from middle of sole to posterior end. Snout short, bilobed. Two long opercular tentacles, left longest. Colour white except for narrow strip of black around edges of opercular lobe and on back of head.

Specimens from Piha on the West Coast of Auckland have uniform white animals and smaller shells, but otherwise they are identical with the east coast form.

Operculum: (Fig. 3). Moderately thickened, oval, columella edge weakly convex. No internal ridge. Muscle insertion area small, dense white, terminating some distance from outer edge as a ragged line, a raised rim along the columella side. Peg strong and grooved. Operculum except for the insertion area, semi-transparent and pale yellow in colour.

Radula: (Fig. 4). Central 3 + 1 + 3. Lateral 2 + 1 + 3, thickened below. Inner marginal denticles 4 + 1 + 1, the fifth a little larger. Outer marginal with about 6 serrations and a broad basal area.

Holotype: (Fig. 1). Goat Island Bay, Leigh, on *Carpophyllum plumosum,* 1/1/64 (W.F.P.) (A.M.).

Height 1.26 mm. Width 0.8 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, and the N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotypes and paratypes; Big King, Three Kings Islands, sublittoral algae, A. Baker (W.F.P.); Spirits Bay, shell sand (Hipkins Coll.); Takapau Kura, Spirits Bay, algae, A. W. B. Powell, -/8/33 (Powell Coll.); Cape Maria van Diemen, Finlay Coll. (per N. H. Odhner) (A.M.); Whangaroa, shell sand, R. K. Dell (D.M.); Taupo Bay, Whangaroa, E. R. Richardson 11/4/51 (D.M.); Poor Knights Islands, hard coralline algae, brown algae 4/4/64 (W.F.P.); MacGregor's Bay, Whangarei Heads, algae, 22/5/63 (W.F.P.); Ocean Beach, Whangarei Heads, red algae, *Carpophyllum maschalocarpum* and various small algae, 9/5/63 (W.F.P.); Kaitoke, Great Barrier Island, short algae, 16/11/63 (W.F.P.); Goat Island Bay, Leigh, *Carpophyllum* and other brown algae, 1962-64 (W.F.P.); North and South Piha, West Coast, Auckland, short soft algae, coralline algae.

-/6/63 (W.F.P.); Jackson's Bay, Coromandel, *Carpophyllum plumosum,* 29/3/64 (W.F.P.); Ohope, *Carpophyllum,* M. West, 24/8/64 (W.F.P.); Cape Runaway, A. W. B. Powell, -/8/33 (Powell Coll.); Tolaga Bay, R. K. Dell, 28/11/50 (D.M.) Lyall Bay, Wellington, *Cystophora,* W. R. B. Oliver, 18/12/21 (D.M.), and Finlay Coll. (A.M.); East side of Lyall Bay, algae, 17/2/56 (W.F.P.); Island Bay, Wellington, algae (D.M.); Titahi Bay, brown algae (W.F.P.); Brothers Island, Cook Strait, algae in several feet of water, D. Hurley -/5/51 (D.M.); Kaikoura, small algae, I. Mannering, -/8/63, and fine brown algae, P. Luckens, 12/8/64 (W.F.P.); Motunau Beach, Canterbury, coralline algae, R. R. Forster, 17/1/48 (D.M.); Taylor's Mistake, Bank's Peninsula, coralline algae, *Cystophora,* W. R. B. Oliver, 10/4/10 (D.M.); East of Purau, Lyttelton Harbour, fine brown algae and fine coralline algae in rock pools, W. R. B. Oliver, 4/9/10 (D.M.); Okain's Bay, Bank's Peninsula, W. R. B. Oliver, 10/11/06 (D.M.); Gollan's Bay, Lyttelton Harbour, brown algae, W. R. B. Oliver, 26/3/10 (D.M.); Shag Point, Otago, *Tiphophora* association, W. R. B. Oliver, 18/1/01 (D.M.); Ships' Channel side of Quarantine Island, Dunedin Harbour, brown algae, 4/9/63 (W.F.P.); Little Papanui, Dunedin, coralline algae, under stones, gelatinous red algae, 5/9/63 (W.F.P.); Taieri Beach, Otago, algae, Finlay Coll. (A.M.); Halfmoon Bay, Stewart Island, O. Allan (D.M.), and algae, E. Smith 12/6/52 (W.F.P.); Aker's Point, Halfmoon Bay, M. Spong, 22/2/63 (W.F.P.); Ocean Beach, Stewart Island, algae, 28/12/52 (Smith Coll.); Harold's Point, Stewart Island, *Corallina,* 18/9/56 (Smith Coll.); Nugget Point, Stewart Island, algae, 17/9/56 (Smith Coll.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.); Doubtful Sound, 50 fathoms (W.F.P.); Open Bay Islets, West Coast, J. A. Bollons, (D.M.); Faith Harbour, Auckland Islands, M. K. Mestayer (A.M.); Faith Harbour, beach drift (A.M.); Chatham Islands, Exped., Stat. 11, Owenga, Chatham Islands, algae, R. K. Dell, 26/1/54 (D.M.); Red Bluff, Chatham Islands, W. R. B. Oliver, 6/12/09 (D.M.); Waitangi, Chatham Islands, algae, W. R. B. Oliver, -/12/09 (D.M.).

Distribution: The East and West Coasts of the North and South Islands, Stewart Island, and the Auckland and Chatham Islands, on algae at low tide.

Ecology: Inhabits clean algae on open coasts. It is particularly abundant in the South Island and Stewart Island.

Eatoniella (Dardaniopsis) globosa n. sp. Plate 8, fig. 8.

Shell thin, fragile, inflated, pinkish, semi-transparent. Whorls three, weakly convex, false margined, with subobsolete spiral scratches. Protoconch dome-shaped, similarly sculptured to the adult whorls, from which it is not marked off. Body whorl comprises most of shell, globose; a weak spiral ridge runs around the convex periphery. Umbilicus large, deep, crescentric, surrounded by a sharp ridge. Aperture pear-shaped, with a slightly thickened, strongly retracted, outer lip which has two chinks, one in middle, other posteriorly. Peristome continuous, rather thin, columella very slightly concave. Colour of first two whorls yellowish brown, the rest pinkish. Umbilical region, columella, and outer lip bright pinkish.

This species is clearly related to *E.* (*D.*) *notalabia,* but at the same time is most distinctive. Animal, operculum and radula unknown.

Holotype: (Fig. 8). Spirits Bay, 1949 (ex Hipkins Coll.) (A.M.).
Height 1.15 mm. Width 0.8 mm.

Paratypes: Auckland and Dominion Museums, N.Z. Geological Survey, Lower Hutt, K. Hipkins Collection.

Material Examined: Holotype and paratypes; MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.).

Distribution: The North and North East of the North Island.

Eatoniella (Dardaniopsis) pullmitra n. sp. Plate 8, figs. 9-11.

Shell, minute, smooth, shining, broadly ovate, with a short, swollen spire. Spire slightly convex, of 4 whorls. Sculpture of weak growth lines. Protoconch small, smooth, depressed, not clearly marked off, adult whorls very rapidly increasing, convex; body whorl globose, base convex. Aperture small, oval, angled above and slightly below; peristome continuous; inner lip concave, slightly thickened, narrow, not covering the large umbilicus; outer lip slightly thickened above and below, notched in its middle and anteriorly, slightly reflected anteriorly. Umbilicus large, deep, wide, bordered by a faint ridge. Colour yellowish-white, semi-transparent, aperture and umbilical area white.

Though superficially similar to *E.* (*D.*) *aterviscerahs* n. sp. and *E.* (*Dardanula*) *dilatata* (Powell), this species is easily distinguished by its broad shell and large umbilicus.

Animal: (Paratype). Visceral mass and mantle roof yellowish, head snout, sides of the foot, and opercular lobes black. Eyes small (preserved material).

Operculum: (Fig. 10). Oval, thin, nearly flat. Peg short, grooved and dense yellowish-white. Muscle insertion area semi-transparent but thickened and rough, yellowish-white, broken a considerable distance from outer edge in a ragged line. Outer area is colourless and transparent.

Radula: (Fig. 11). Typical of the genus. Central 2 + 1 + 2, lateral 2 + 1 + 2, with a strong basal process and dorsal rib. Inner marginal 3 + 1, the outermost cusp strong. Outer marginal with about 6 serrations and a broad base.

Holotype: (Fig. 9). Ships' Channel side of Quarantine Island, on soft brown algae, 4/9/64 (W.F.P.) (A.M.).

Height 1.23 mm. Width 0.85 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Big King, Three Kings Islands, sublittoral algae, A. Baker (W.F.P.); Spirits Bay, shell sand (Hipkins Coll.); 4 fathoms between Cape Maria Island and mainland, -/2/61 (Hipkins Coll.); Brother's Island, Cook Strait, sublittoral algae, D. E. Hurley, -/5/51 (D.M.); Gollan's Bay, Lyttelton Harbour, brown algae, W. R. B. Oliver, 26/3/10 (D.M.); Portobello, Dunedin Harbour, *Corallina,* soft red algae, 3/9/63 (W.F.P.); Ships' Channel side of Quarantine Island, Dunedin Harbour, *Corallina,* 4/9/63 (W.F.P.); Portobello, Dunedin Harbour, 2-3 fathoms on algae, 3/9/63 (W.F.P.); Foveaux Strait, 1951 (Smith Coll.); Butterfield's Beach, Stewart Island, shell sand, O. Allan, -/10/47 (W.F.P.); Bathing Beach, Stewart Island, shell sand, O. Allan, 1950 (W.F.P.); 10 fathoms off Native Island, Stewart Island, algae, -/12/58 (Smith Coll.); 25 fathoms off Port Adventure, Stewart Island, fine bryozoans, -/6/58 (Smith Coll.); 50 fathoms, Doubtful Sound (W.F.P.); Waitangi, Chatham Islands, rocks between tides, W. R. B. Oliver, -/12/09 (D.M.); Red Bluff, Chatham Islands, W. R. B. Oliver, 6/12/09 (D.M.).

Distribution: The distribution of this species is complicated because of its preference for sublittoral algae. The Far Northern records suggest that it is found throughout the North Island, probably most abundantly in sublittoral algae, but there is no evidence to support this conclusion

apart from the record from Cook strait. *E.* (*D.*) *pullmitra* is found commonly in the littoral zone in Dunedin Harbour, but at Stewart Island it has only been recorded from the sublittoral. Only dead shells have been found at the Chatham Islands.

Eatoniella (Dardaniopsis) varicolor n. sp. Plate 8, figs. 5-7.

Shell of medium size for genus, ovate, conic, smooth, variable in colour, imperforate, outer lip strongly reflected and bisinuate laterally. Spire rather short, of 4 lightly convex whorls. Protoconch small, smooth, varying from pink to purple, not distinctly marked off, often coloured darker than the spire. Aperture rather large, columella concave, inner lip thickened; outer lip thin anteriorly, thickened posteriorly, the thin anterio-lateral portion bisinuate. Inner lip and umbilical area pinkish in holotype, spire yellowish-brown. Colour, however, highly variable, even within one population, this appearing to be a characteristic of the species. Dark purple, black, orange, very pale yellow, colourless, plain and banded shells are found together. The most common colour is pale brownish-yellow.

E. (*D.*) *varicolor* resembles *E.* (*A.*) *lutea* (Suter), and the two species are frequently found together. The new species is readily distinguished by its smaller size, thinner shell, sinuate aperture, different coloration, and particularly the dark protoconch and the inner lip which is frequently pinkish. *E.* (*A.*) *lutea* usually has a uniform coloration. Some specimens have pink bands and superficially resemble *E.* (*Dardanula*) *roseocincta* (Suter). It could also be confused with *E.* (*Dardanula*) *roseospira* (Powell) by virtue of its dark protoconch, but that species is smaller, with an evenly convex outer lip.

Animal: (Fig. 6). (Paratype). Typical of the subgenus. Cephalic tentacles colourless, mobile and protrude from the dents in aperture; eyes remain below transparent rim of shell. Snout bilobed, short, with a golden tinge; buccal mass orange-red. Rest of animal yellowish-white, except for outer margins of opercular lobes and lateral margins of foot, which are black, and the white sole. Posterior mucous gland large, opening into a slit which extends from centre of sole to posterior end. Two long opercular tentacles, one on each side, the left longest.

Operculum: On retracted animal appears to have black edges owing to pigmentation of opercular lobes. Oval, thickened, muscle insertion area small, terminated by an irregular line some distance from outer edge and bordered by a raised rim on columella edge. Peg strong, curved, and grooved. Sculpture of strong growth lines and fine spirals.

Radula: Typical of the genus. Central 2 + 1 + 2, lateral 2 + 1 + 3, the cusps weak; with a strong basal and dorsal ridge. Inner marginal with 3 tiny denticles on either side of a weak, broad cusp. Outer marginal finely serrate.

Holotype: Narrow Neck Reef, on *Carpophyllum plumosum* in rock pools, W.F.P., 27/3/63 (A.M.).

Height 1.73 mm. Width 1.13 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Great Island, Three Kings Islands, sublittoral algae, A. Baker (W.F.P.); Spirits Bay, shell sand (Hipkins Coll.); Taupo Bay, Whangaroa, E. R. Richardson, 11/4/51 (D.M.) and 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, -/1/55 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); Goat Island Bay, Leigh, brown algae, 1963-64 (W.F.P.); Tawaharanui Point, North side, brown algae, in pools on papa platform, 31/12/63 (W.F.P.); Brown's Bay, Auckland, brown algae, 19/1/64 (W.F.P.); Takapuna, Auckland, *Carpophyllum plumosum*, 27/3/63 (W.F.P.); Narrow Neck, Auckland, *Carpophyllum* spp., 26/3/63 (W.F.P.); Sandy Bay, Coromandel, brown algae, 30/3/64 (W.F.P.); off Mayor Island, in fish stomach contents, G. Williams (Powell Coll.); Tolaga Bay, shell sand, R. K. Dell, 28/11/50 (D.M.); Kaiti Beach, Gisborne, R. K. Dell, 26/11/50 (D.M.); Lyall Bay, *Cystophora*, W. R. B. Oliver, 18/12/21 (D.M.); Island Bay, Wellington, brown algae, *Corallina*, 3/6/63 (W.F.P.); Scorching Bay, Wellington, brown algae, 26/11/61 (W.F.P.); between Pukerua Bay and Plimmerton, on algae holdfasts washed ashore, 18/6/60 (W.F.P.); Brother's Island, Cook Strait, sublittoral algae, D. H. Hurley, -/5/51 (D.M.); East of Diamond Harbour, Lyttelton Harbour, *Corallina*, brown algae, under stones, -/9/63 (W.F.P.); Taylor's Mistake, Bank's Peninsula, coralline algae, W. R. B. Oliver, 10/4/10 (D.M.); Ships' Channel side, Quarantine Island, Dunedin Harbour, fine red algae, 4/5/63 W.F.P.); Portobello, Dunedin Harbour, brown algae, 3/9/63 (W.F.P.); Bluff Harbour, *Corallina*, M. Spong, 27/5/63 (W.F.P.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.); Nugget Point, Stewart Island, algae, 17/9/56 (Smith Coll.); 8 fathoms, off mouth of Halfmoon Bay, Stewart Island, clean algae, 16/4/59 (Smith Coll.); Doubtful Sound, 50 fathoms (W.F.P.); Open Bay Islets, West Coast, J. A. Bollons (D.M.); Chatham Island Expedition, Port Hutt, Chatham Island, 8/2/54 (D.M.).

Distribution: The East Coasts of the North and South Islands, the South West Coast of the South Island, and Stewart Island. The single record from the Chatham Islands need confirmation.

Ecology: *E.* (*D.*) *varicolor* prefers brown algae as a habitat, though it is sometimes encountered in *Corallina*. *Carpophyllum plumosum* is preferred to *C. maschalocarpum* at Takapuna and Narrow Neck. This species is encountered in immense numbers on *C. plumosum* in moderately sheltered situations, such as rock pools, at Takapuna, Narrow Neck, Waiwera and many other localities in the vicinity of Auckland. In more exposed situations it is replaced by *E.* (*A.*) *lutea*, while in silted localities *E.* (*D.*) *limbata* (Hutton) and *E.* (*D.*) *olivacea* (Hutton) dominate. There is some evidence that it is abundant below low tide level through most of New Zealand.

Eatoniella (Dardaniopsis?) aterivisceralis n. sp. **Pl. 8, figs. 12-15.**

Shell minute, conical, smooth, shining, with convex whorls, transparent. Whorls $4\frac{1}{2}$, strongly convex; protoconch not marked off, small. Sculpture absent except for slightly oblique growth lines, these sometimes strong. Sutures indistinctly false margined. Body whorl large, inflated. Aperture oval, slightly angled posteriorly; peristome continuous, fairly thin; inner lip evenly concave, narrow, columella nearly vertical. Outer lip slightly retracted, evenly convex, hardly thickened. Umbilicus a small chink, but deep and definite and always present. Colour yellowish-white, aperture and lower part of base white.

There is some variation in size and in the relative height of the spire (c.f. figs. 12 and 13). This species can be distinguished from *E.* (*D.*) *pullmitra* which it closely resembles, by its smaller umbilicus, evenly convex outer lip, taller spire, and the colour of the animal. It can be separated from *E.* (*Dardanula*) *dilatata* (Powell), which it super-

ficially resembles, by the narrow inner lip which does not cover the umbilicus, and the oval, rather than obliquely D-shaped, aperture, of which the columella is nearly vertical, and the peristome rounded, instead of angled, where it meets the outer lip below. Also the body whorl is less swollen in most specimens of *atervisceralis*.

Animal: (Portobello, Dunedin). The visceral mass and mantle cavity roof are pigmented with large, irregular, close black blotches or are uniform jet-black. The head and foot are unpigmented (preserved material). The black visceral mass can be easily seen in dried material that has been collected alive, thus facilitating identification.

Operculum: (Fig. 14). Oval, fairly thick, slightly curved. Muscle insertion area transparent, not greatly thickened, but rough, pale yellowish and broken irregularly some distance from outer edge which is clear and colourless. Peg of moderate length, yellowish, curved. Nucleus fairly clearly defined and rather large for genus.

Radula: (Fig. 15). Typical of genus. Central 2 + 1 + 2, lateral 2 + 1 + 2, with a strong basal rib; inner marginal 1 + 1 + 2, the second denticle rather weak, outer marginal finely serrate.

Holotype: (Fig. 12). Lonneker's Bay, Stewart Island, in coralline algae at low tide, -/10/51 (ex Smith Coll.) (A.M.).

Height 1.23 mm. Width 0.75 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt and E. Smith Collection.

Material Examined:

Holotype and paratypes; Spirits Bay, shell sand, (Hipkins Coll.); Taupo Bay, Whangaroa, shell sand, 2/1/54 (Hipkins Coll.); Poor Knights Islands, under stones in pools, 4/4/64 (W.F.P.); Mokohinau Islands (W.F.P.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); Smuggler's Bay, Whangarei Heads, under stones, 21/5/63 (W.F.P.); Goat Island Bay, Leigh, under stones, 1/1/64 (W.F.P.); Jackson's Bay, Coromandel, under stones, 30/3/64 (W.F.P.); Shag Point, Otago, *Tiphohora*, association, W. R. B. Oliver, 18/1/01 (D.M.); Little Papanui, Dunedin, coralline algae, 5/9/63 (W.F.P.); Portobello, Dunedin Harbour, *Corallina* and soft red algae, 3/9/63 (W.F.P.); Ships' Channel side, Quarantine Island, Dunedin Harbour, *Corallina*, 4/9/63 (W.F.P.); Taieri River Mouth, coralline algae, W. Ballantine, 27/6/64 (W.F.P.); Taieri Beach, algae, Finlay Coll., (A.M.); Bluff Harbour *Corallina*, M. Spong, 27/5/63 (W.F.P.); Aker's Point, Halfmoon Bay, Stewart Island, under stones, M. Spong, -/2/63 (W.F.P.); Butterfields Beach, Stewart Island, shell sand, O. Allan, -/10/47 (D.M.); Ocean Beach, Stewart Island, R. K. Dell, 31/10/48 (D.M.) and 1/12/52 (Smith Coll.); Lonneker's Bay, Stewart Island, algae below first line of *Durvillea*, -/3/57 (Smith Coll.); Paterson Inlet, algae, 15/9/56 (Smith Coll.); Waitangi, Chatham Islands, rocks between tides, W. R. B. Oliver, -/12/09 (D.M.); Chatham Island Exped. Stat. 16, Kaingaroa, 27/1/54 (D.M.).

Distribution: The East Coasts of the North and South Islands, Stewart Island and the Chatham Islands, living in turf-algae and under stones from low tide to a few fathoms. It is much more abundant in the South. Apparently this species has escaped notice in many localities because of its small size and inconspicuous shell.

E. aterviscerallis is placed only tentatively in *Dardaniopsis* as the aperture has an even outer margin. Examination of the living animal should help fix its taxonomic position.

Subgenus **Dardanula** Iredale, 1915.

(Nom. nov. pro *Dardania* Hutton, 1882, non Stal, 1860).

Type (monotypy) : *Dardania olivacea* Hutton, 1882.

Several New Zealand eatoniellids are similar to the type of *Dardanula,* but show, as a group, several small, but constant, differences from *Eatoniella* (s.s.). The group appears to form a fairly natural subgenus of *Eatoniella* but certainly does not deserve full generic rank.

Shell: Solid, conical, usually opaque. Protoconch opaque, of same colour as adult shell. Whorls weakly to moderately convex. Aperture solid, ovate to D-shaped, inner lip heavy, outer lip straight or excavated, simple, thickened, and bent downwards slightly posteriorly. Usually not umbilicate.

Animal: Opercular tentacles absent or one on left lobe. Right lobe with no definite group of mucous cells.

Operculum: Solid, muscle insertion area extensive, opaque, only a small area to left of peg sometimes transparent. Internal ridge present or absent. Spiral sculpture weak or absent. Colour black, brown or yellowish.

Radula: Shape of teeth typical. Central typically 2 + 1 + 2 (but 3 + 1 + 3 in two species), lateral 2 + 1 + 2, inner marginal 3 in the majority of species, (1 in one species, 5 and 6 in two other species) outer marginal finely serrate.

Eatoniella (Dardanula) olivacea (Hutton). Plate 5, figs. 1-7.

1882 *Dardania olivacea* Hutton, Trans. N.Z. Inst., 14, p. 147, pl. 1, fig. K, 1-4.
1884 *Rissoina olivacea* var. *annulata* Hutton, N.Z. Journ. Sci. 2, p. 173.
1898 *Rissoina olivacea* (Hutton); Suter, Proc. Mal. Soc. Lond., 3, p. 7.
1905 *Rissoina olivacea* (Hutton); Webster, Trans. N.Z. Inst., 37, (1904), (1905), p. 279, pl. 10, fig. 9, a.
1905 *Rissoina olivacea* var. *annulata* Hutton; Webster, Trans. N.Z. Inst. 37, p. 279.
1913 *Rissoina* (*Eatoniella*) *olivacea* (Hutton); Suter, Man. N.Z. Moll. p. 225, pl. 13, fig. 19.
1913 *Rissoina* (*Eatoniella*) *olivacea* var. *annulata* Hutton; Suter, Man. N.Z. Moll. p. 226, pl. 13, fig. 19.
1915 *Dardanula olivacea* (Hutton); Iredale, Trans. N.Z. Inst.., 47, p. 454.
1937 *Dardanula olivacea annulata* (Hutton); Powell, Shellfish of N.Z. p.70.

Specimens labelled as cotypes of *Dardanula olivacea* in the Canterbury Museum (fig. 3) do not match shells from the type locality (Lyttelton Harbour) nor do they resemble cotypes in the Dominion Museum. The latter types do match Lyttelton Harbour shells and it is clear that these represent a portion of Hutton's type material. A specimen selected from these is designated as lectotype (fig. 1) and described below.

Shell conic, solid, imperforate, outlines of spire straight, whorls very slightly convex; protoconch small, not marked off, smooth. Colour purplish-black, columella white over central part, outer lip lighter in colour than rest of shell. Aperture oval, angled posteriorly; outer lip hardly reflected, slightly thickened; columella and inner lip moderately thickened. Periphery subangled.

The species shows considerable variation. Shells in the North can be, on the whole, separated into two size forms. A small variety (fig. 2,

3), with convex whorls, a short spire, (about 1.6-2 mm. high) inflated body whorl and weakly angled periphery, which is by far the commoner of the two forms. The larger form (fig. 4) (about 2.88 mm. high) lives almost exclusively, on brown algae. However shells of intermediate size are fairly common and there is no reasonable indication that these size groups should be separated, as the shells are generally similar and there are no differences in the animal, the operculum, or the radula.

Hutton's var. *annulata* is a variation of *olivacea,* and is particularly abundant in the North East of the North Island. Typical annulate shells belong to the 'small form' already mentioned, and they show every intergradation through uniform black, narrow banded, wide banded and uniform yellow shells. The large form also, rather uncommonly, produces annulate shells. These size forms and the annulate shells do not seem to occur in the southern part of the North Island nor the South Island.

E. olivacea is distinguished from the other species of the genus by its nearly straight apertural margin, dark brown or black operculum, and solid, usually black, shell. The animal too, is distinctive.

Animal: (Auckland). (Fig. 7). Cephalic tentacles long, tapering, actively mobile smooth; eyes in swellings at outer bases. Snout bilobed, short. Foot long, bluntly rounded behind, anterior margin slightly convex, extensile. Mucous slit clearly defined, from middle of sole to posterior end. No opercular tentacles, but an ill-defined group of scattered mucous cells on right opercular lobe, and sometimes a tiny swelling on left lobe which probably represents a rudimentary tentacle. Colour dominantly black, the pigmentation rather dense over most of the exposed parts of the animal. Terminal part of snout white, the orange-red buccal mass visible through the integument. Sole white, cephalic tentacles colourless or "dusted" with black. Notes on the anatomy are given in a forthcoming publication. (Ponder,—a).

The black colour, orange-red buccal mass, and absence of opercular tentacles separate this species from all others of the genus.

Operculum: (Figs. 5, 5a, 5b). Pear shaped, thick, slightly curved, centre dark brown to nearly black, edges black, except columella edge which is brown. Muscle insertion area extensive; peg rather short, curved upwards, thick. Internal ridge rather strong, wide. Growth lines and faint incised spirals visible on outer surface. Inner surface with no sculpture.

Radula: (Fig. 6). Typical of the genus. Central 2 + 1 + 2, marginal 2 + 1 + 2, rather broad, with strong basal ridge and weak ridge on top edge. Marginals typical, inner with three cusps, outer with fine serrations.

Lectotype: (Fig. 1). Lyttelton Harbour (D.M.).
Height 1.88 mm. Width 1.01 mm.

Material Examined:

Lectotype, paralectotypes; Great Island, Three Kings Islands, sublittoral algae, A. Baker (W.F.P.); 4 fathoms, between Cape Maria van Diemen and mainland, -/2/61 (Hipkins Coll.); Spirits Bay, shell sand (Hipkins Coll.); Takapau Kura, Spirits Bay, algae (Powell Coll.); North Cape, small algal formation, W. R. B. Oliver, 24/11/16 (D.M.); Doubtless Bay, A. E. Brookes, Oliver Coll. (D.M.); Waiau Beach, Mangonui, E. R. Richardson, 11/12/50 (D.M.); Whangaroa, Finlay Coll. (A.M.); East of Oneroa, Bay of Islands,

Carpophyllum spp., -/11/62 (W.F.P.); Whangaruru, shell sand, 16/2/56 (D.M.); Ocean Beach, Whangarei Heads, various algae, 7/5/62 (W.F.P.); Smuggler's Bay, Whangarei Heads, various algae, under stones, 5/5/62 (W.F.P.); MacGregor's Bay, Whangarei Heads, algae, under stones, 22/5/63 (W.F.P.); Taurikura Bay, Whangarei Heads, *Corallina*. -/5/63 (W.F.P.); Poor Knights Islands, hard coralline algae, 4/4/64 (W.F.P.); Bream Tail, *Carpophyllum* spp., *Corallina*, 12/8/63 (W.F.P.); Goat Island Bay, Leigh, *Carpophyllum* spp., *Corallina*, small algae, under stones, 1963-64 (W.F.P.); Tawharanui Point, North and South side, brown algae, under stones, 31/12/63 (W.F.P.); Okupu, Great Barrier Island, *Carpophyllum*, under stones, *Corallina*, -/11/63 (W.F.P.); Kaitoke, Great Barrier Island, short algae, under stones, 16/11/63 (W.F.P.); Shoal Bay, Tryphena, Great Barrier Island, algae, 6/1/51 (Hipkins Coll.); Tryphena, Great Barrier Island, shell sand, 13/1/51 (Hipkins Coll.); Waiwera, *Carpophyllum* spp., *Corallina*, 16/2/64 (W.F.P.); Noises Islands, Hauraki Gulf, G. Sadler (Powell Coll.); Brown's Bay, Auckland, brown algae, 19/1/64 (W.F.P.); Campbell's Bay, Auckland, *Caulerpa*, W. Ballantine (W.F.P.); Takapuna, Auckland, *Carpophyllum* spp., *Corallina*, 1962-64 (W.F.P.); Devonport, Auckland, Webster Coll. (Powell Coll.); Point Chevalier Reef, Auckland, Dell Coll. (D.M.); Narrow Neck Reef, Auckland, *Corallina, Sargassum*, under stones 1963-64 (W.F.P.); Stanley Point, Auckland, *Sargassum*, 1963 (W.F.P.); St. Heliers Bay, Auckland, Finlay Coll. (A.M.); West Tamaki Heads, *Corallina*, -/8/62 (W.F.P.); Jackson's Bay, Coromandel, *Carpophyllum plumosum*, fine red algae, 29/3/64 (W.F.P.); Sandy Bay, Coromandel, *Corallina*, brown algae, 30/3/64 (W.F.P.); Stony Bay, Coromandel, 28/3/64, brown algae, *Corallina*, short algae, 28/3/64 (W.F.P.); Cornwallis, Manukau Harbour, under stones, *Corallina*, 7/1/62 (W.F.P.); off Mayor Island, fish stomach contents, G. Williams (Powell Coll.); Waihi *Corallina* (W.F.P.); Waihau Beach, Cape Runaway, R. K. Dell, 8/3/62 (D.M.); Cape Runaway, under stones, algae, -/8/33 (Powell Coll.); Tolaga Bay, shell sand, R. K. Dell, 28/11/50 (D.M.); Gisborne, shell sand, 1906 (D.M.); Kaiti Beach, Gisborne, shell, sand, R. K. Dell, 26/11/50 (D.M.); Day's Bay, Wellington Harbour, algae, 11/12/61 (W.F.P.); Island Bay, Wellington, various brown algae, *Corallina*, 28/2/59 and 3/6/62 (W.F.P.); Lyall Bay, Wellington, Finlay Coll. (A.M.); Owhiro Bay, Wellington, *Corallina*, brown algae, 20/ 2/63 (W.F.P.); Titahi Bay, *Corallina*, brown algae, 5/6/62 (W.F.P.); Karehana Bay, Plimmerton, large brown algae, 7/12/61 (W.F.P.); Paremata Harbour, 1957 (W.F.P.); between Pukerua Bay and Paekakariki, brown algae, 24/12/61 (W.F.P.); Long Beach, Durville Island, rock pools, W. R. B. Oliver, 13/2/43 (D.M.); Tahunanui Beach, Nelson, shell sand (Powell Coll.); Cape Campbell, coralline algae, W. Ballantine, 16/2/64 (W.F.P.); Kaikoura, small algae, I. Mannering, -/8/63, *Corallina*, R. A. Russmussen, 12/6/64, fine brown algae, P. Luckens, 12/8/64 (W.F.P.); Oaro, South of Kaikoura, *Corallina*, W. Ballantine, 19/2/64 (W.F.P.); Taylor's Mistake, tall coralline algae, -/9/63 (W.F.P.); Purau, Lyttelton Harbour, shell sand, 1/1/07 W. R. B. Oliver (D.M.); East of Purau, Lyttelton Harbour, fine brown algae, coralline algae, W. R. B. Oliver, 4/9/10 (D.M.); East of Diamond Harbour, Lyttelton Harbour, *Corallina*, under stones, -/9/63 (W.F.P.); Gollan's Bay, Lyttelton Harbour, brown algae, W. R. B. Oliver, 26/3/10 (D.M.); Okain's Bay, Bank's Peninsula, W. R. B. Oliver, 10/11/06 (D.M.); Oamaru, Finlay Coll. (A.M.); Bushy Beach, Oamaru, coralline algae, W. Ballantine, 24/2/64 (W.F.P.); Little Papanui, Dunedin, gelatinous red algae, coralline algae, 5/9/63 (W.F.P.); Ship's Channel side of Quarantine Island, Dunedin Habour, brown algae, *Corallina*, fine red algae, 4/9/63 (W.F.P.); Bluff, *Corallina*, M. Spong, 27/5/63 (W.F.P.); Ewing Island, Port Ross, Auckland Island, Cape Expedition, R. A. Falla (A.M.); Waitangi, Chatham Islands, rock pools, algae and rocks between tides, W. R. B. Oliver, 8/12/09 (D.M.); Tionori, Chatham Islands, Dell. Coll. (D.M.).

Distribution: The North and South Islands, Stewart Island, Auckland Islands and the Chatham Islands. Annulate shells and the 'large form' are restricted to the North East of the North Island.

Ecology: *E. (D.) olivacea* is found in the littoral zone and down to a few fathoms where it lives on algae. In the vicinity of Auckland, finely divided algae (e.g. *Corallina* and *Carpophyllum plumosum*) is the favoured habitat of the 'small form', while the 'large form' (see above) is found almost exclusively on brown algae on open coasts. The species is rare under stones and in crevices.

Eatoniella (Dardanula) dilatata (Powell). Plate 7, figs. 13-15.

1955 *Notosetia dilatata* Powell, D.S.I.R., Bull. 15, Cape Exped. Series, p. 86, p. 13, fig. 21.
1962 *Notosetia dilatata* Powell; Smith, Rec. Dom. Mus. 4 (5), p. 52, fig. 7.

This species can be distinguished by its solid, oblique D-shaped aperture, swollen body whorl, small size, semi-transparent shell and short spire. The umbilical chink is visible in juveniles, but in adults it is covered by the thickened inner lip. The outer lip is thickened above and below, the thin middle part being slightly reflected. The colour is yellowish-white, except for the base and aperture which are white.

There is some variation in the size, the convexity of the whorls and the strength of the inner lip.

A series of shells from Whangarei Heads closely resembles the southern *dilatata* but no specimens from intermediate localities have been seen.

Animal: (Stewart Island). The exposed parts are unpigmented. The mantle and visceral mass are brownish to black (dried material).

Operculum: (Fig. 14). Oval, rather thick, semi-transparent except muscle insertion area, with a strong grooved peg. Marginal areas yellow. Muscle insertion area rather extensive, dense yellowish white, broken on left end. There is faint spiral sculpture developed and growth lines are clearly visible. Nucleus rather large for genus.

Radula: (Fig. 15). Typical of subgenus. Central 2 + 1 + 2, lateral 2 + 1 + 2. There are a few very fine serrations along a weak dorsal ridge lateral to outside denticle. Inner marginal with three small cusps, outer largest. Outer marginal with about 6 serrations and a broad base.

Holotype: (Fig. 13). Snares Islands, 50 fathoms, (ex Finlay Coll.) (A.M.).

Height 1.05 mm. Width 0.78 mm.

Material Examined:

Holotype and paratypes; MacGregor's Bay, Whangarei Heads, shell sand (Hipkins Coll.); Lyall Bay, Wellington, Finlay Coll. (A.M.); Lyall Bay (D.M.); Foveaux Strait, 1951 (Smith Coll.); Butterfield's Beach, Stewart Island, shell sand, -/10/47 (D.M.); Aker's Point, Halfmoon Bay, Stewart Island, 22/2/63, shell sand, M. Spong (W.F.P.); Poutama Island, South Cape, Stewart Island, 30 fathoms, -/6/55 (Smith Coll.); off East end of Ulva Island, Stewart Island, in kelp holdfast, -/8/57 (Smith Coll.); B.S. 137, off Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin, 8/1/52 (D.M.); 50 fathoms, Doubtful Sound (W.F.P.); 50 fathoms, Snares Islands, Finlay Coll. (A.M. and Powell Coll.); Waitangi, Chatham Islands, rocks between tides, W. R. B. Oliver, -/12/09 (D.M.); Waitangi, shell sand, -/1/33 (A.M.); Red Bluff, Chatham Islands, W. R. B. Oliver, 6/12/09 (D.M.).

Distribution: The East Coast of the North and South Islands, Fiordland, Stewart Island, and the Snares and Chatham Islands. In the northern part of its range, this species is very poorly known and rare.

Eatoniella (Dardanula) fossa n. sp. Plate 7, fig. 21.

Shell of medium size for subgenus, solid, smooth, shining, ovate-conic, a groove between inner-lip and body whorl. Spire rather tall, very slightly convex; whorls 4½, faintly convex, smooth and polished; protoconch smooth, small; sutures distinctly false margined; body

whorl with a rounded periphery and base. Aperture small, rounded, slightly angled posteriorly, with a deep groove between inner lip and body whorl. Peristome continuous, thickened, especially in posterior corner; outer lip thickened internally, with a sharp edge, hardly excavated. Colour of dead shells varies from brownish-yellow to white, a band below the sutures may be darker or lighter than rest of shell; aperture and umbilical region white. A few irregular zig-zag markings sometimes developed on last part of body whorl from a peripherial dark band or small dark blotches. The dark subsutural band, if present, may break up into irregular blotches on the body whorl. Holotype yellowish-white with a few faint brown blotches on last part of body whorl and a large reddish-brown blotch just behind aperture.

This species is easily distinguished from all the other members of the genus by the channel between the aperture and the body whorl. Though this is similar to that seen in *Scrobs,* the resemblance is only superficial; other shell characters showing that this species is an eatoniellid.

Animal, operculum and radula unknown.

Holotype: (Fig. 21). 22 fathoms, ½ mile off West side of Stephenson's Island, 3½ miles from Whangaroa, 29/12/53 (ex Hipkins Coll.) (A.M.).

Height 1.9 mm. Width 1.2 mm.

Paratypes: Auckland and Dominion Museums, N.Z. Geological Survey, Lower Hutt, K. Hipkins Collection.

Material Examined: Holotype and paratypes.

Distribution: Off Whangaroa in moderately deep water.

Eatoniella (Dardanula) fuscosubucula n. sp. **Pl. 7, figs. 10-12.**

Shell small, broadly conical, with a large D-shaped aperture, white, but with a brown, inner chitinous layer showing through. Spire short, whorls 4, rapidly increasing, convex, sutures indistinctly false margined; body whorl large, swollen, periphery and base rounded. Aperture large, D-shaped; peristome thickened, continuous; inner lip concave, wide, expanded, columella nearly vertical, produced below. Outer lip thickened posteriorly and internally, sharp edged and strongly excavated. Colour of spire dark yellowish-brown due to chitinous layer showing through, the otherwise transparent-white. Aperture and lower part of base white.

Though similar to *E.* (*D.*) *dilatata* (Powell), *fuscosubucula* is easily distinguished by its colour and larger size. It differs from *E.* (*D.*) *verecunda* (Suter) in its smaller size, relatively larger aperture, thinner shell and the brown inner layer.

Animal: (Portobello). Unpigmented, and typical of the genus. (Preserved material).

Operculum: (Fig. 11). D-shaped, convex, marginal areas wide, transparent, yellowish, peg curved, solid, grooved. Muscle insertion area extensive, yellow. Very weak growth lines and spirals present.

Radula: (Fig. 12). Central rather small, 2 + 1 + 2; lateral 2 + 1 + 2, with dorsal and ventral thickenings. Inner marginal with one broad cusp

and a long basal process. Outer marginal finely serrate, with a broad base. The structure of the inner marginal tooth is unique in the family.

Holotype: (Fig. 10). Thule North, Paterson Inlet, Stewart Island, -/1/50 (ex Smith Coll.) (A.M.).

Height 1.4 mm. Width 0.95 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt, Smith Collection.

Material Examined:

Holotype and paratypes; Portobello, Dunedin Harbour, *Corallina,* under stones, soft red algae, 2/9/63 (W.F.P.); Ships' Channel side of Quarantine Island, Dunedin Harbour, *Corallina,* 4/9/63 (W.F.P.); Bathing Beach, Stewart Island, O. Allan 1950 (D.M.); off Jaques Lees Island, Stewart Island, 30 fathoms, O. Allan, -/4/51 (D.M.); off Pontama, South Cape, Stewart Island, 30 fathoms, in craypot, -/6/55 (Smith Coll.); Cape Expedition, Ewing Island, Port Ross, Auckland Islands, R. A. Falla (A.M. and D.M.).

Distribution: The South of the South Island, Stewart Island, and the Auckland Islands, from low tide to moderately deep water.

Eatoniella (Dardanula) latebricola n. sp. Plate 7, figs. 3-6.

Shell of moderate size for genus, smooth, solid, semi-transparent, yellowish-white, broadly-conical, spire about same height as aperture. Whorls 4, rapidly increasing, weakly convex; protoconch smooth, not marked off; sutures false margined; body whorl large, convex. Aperture large, D-shaped, solid; inner lip wide, thick, flanged below; outer lip thickened above, below and slightly in middle portion where it is strongly excavated. Imperforate, but a small slit between inner lip and body whorl due to growth of the former over the latter. Colour pale yellowish-white, aperture white.

Animal: (Fig. 4). Cephalic tentacles moderately long, slightly tapered, mildly active, colourless; eyes large, on swellings at outer base of tentacles, and beneath transparent shell edge. Snout short, bilobed, pale yellowish; buccal mass orange, yellow in juveniles. Foot long, rounded anteriorly and posteriorly, with a slit from middle of sole to posterior end, posterior mucous gland clearly visible ventrally as a dense white mass, rest of foot semi-transparent white. Opercular lobe white, a very short tentacle sometimes present on the left side. The anatomy is like that of *Eatoniella* (*Pellax*) *huttoni* and *E.* (*D.*) *olivacea* (Ponder—a). The stomach contains fragments of algal material similar to that of the *Durvillea* holdfast under which the animal lives.

Operculum: (Fig. 5). D-shaped, curved, columella marginal area wide, transparent, yellowish. Muscle insertion area extensive, pale brown near the columella edge, brownish yellow in central area, yellow near outer edge, white at outer edge. Peg heavy, grooved, curved.

Radula: (Fig. 6). Typical of the genus. Central 2 + 1 + 2, large. Lateral rather small, elongate, 2 + 1 + 2, with weak dorsal and ventral thickenings. Inner marginal with 6 small cusps, and a small cusp-like process on outer side, rather broad with a short basal process. Outer marginal finely serrate, with a broad base.

Holotype: (Fig. 3). South end of Muriwai, under *Durvillea* holdfasts, 19/8/63, W.F.P. (A.M.).

Height 1.65 mm. Width 1.05 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined: Holotype and paratypes; Piha under *Durvillea* holdfasts, 1962-64 (W.F.P.).

Distribution: The Auckland West Coast, underneath the holdfasts of the giant kelp, *Durvillea antarctica.*

Eatoniella (Dardanula) limbata (Hutton). **Plate 5, figs. 10, 11.**

1883 *Cingula limbata* Hutton, N.Z. Journ. Sci. I, p. 477.
1884 *Cingula limbata* Hutton; Hutton, Trans. N.Z. Inst. 16, p. 214.
1887 *Rissoa* (*Setia*) *limbata* (Hutton); Tyron, Man. Conch. 9, p. 355, pl. 71, fig. 98.
1898 *Phasianella limbata* (Hutton); Suter, Proc. Mal. Soc. 3, p. 8.
1905 *Rissoina* (*Eatoniella*) *limbata* (Hutton); Webster, Trans. N.Z. Inst., 37, p. 278, pl. 10, fig. 8, 8a.
1913 *Rissoina* (*Eatoniella*) *limbata* (Hutton); Suter Man. N.Z. Moll. p. 225, pl. 13, fig. 18.
1915 *Dardanula limbata* Hutton; Iredale, Trans. N.Z. Inst., 47, p. 454.

The large, solid shell of this species is rendered distinctive by white zig-zag markings on a light greyish-brown to black background. These markings are variably developed, sometimes extending over the whole whorl, or as in the type, restricted to a sutural and/or peripheral series. On shells from some localities the white markings are hardly present, only a few irregular streaks occurring at wide intervals. The whorls are flat to very lightly convex and the periphery is angled.

Animal: (Auckland Harbour). Cephalic tentacles tapering, long, actively motile, and colourless. Snout bilobed, short. Foot moderately long, with a well defined slit in posterior half of sole. Opercular lobe with a short tentacle on left side. Colour variable, usually with some black pigmentation, though this not as heavily developed as in *E.* (*D.*) *olivacea.* The body is usually grey, and sometimes with a green tinge. The buccal mass is orange and the opercular lobes black.

Operculum: Thickened, oval, with an extensive muscle insertion area, strongly curved. Marginal area narrow, bordered internally by a black line. A broad, strong internal ridge present. Colour yellowish to brownish with some black marginal patches internally, but externally with more black, the central area being yellowish to grey. Peg yellow, strong, curved, with a terminal flange. Sculpture of fine spiral lines and rather strong growth lines.

Radula: Typical of subgenus. Central 3 + 1 + 3, lateral 2 + 1 + 2, inner marginal with three small cusps, outer with about 12 serrations.

Lectotype: (Fig. 10). (Here designated) Auckland (Cant. Mus.).

Height 2.4 mm. (estim.). Width 1.5 mm.

Material Examined:

Lectotype and paralectotypes; between Cape Maria Island and mainland, 4 fathoms, -/2/61 (Hipkins Coll.); Spirits Bay, shell sand, (Hipkins Coll.); Taupo Bay, Whangaroa, E. R. Richardson, 11/4/51 (D.M.) and 12/1/54 (Hipkins Coll.);

Whangaroa, W. LaRoche, Finlay Coll. (A.M.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.); Russell, Bay of Islands (Powell Coll.); Oneroa, Bay of Islands, under stones, -/11/62 (W.F.P.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.) and algae, under stones, 22/5/63 (W.F.P.); Taurikura Bay, Whangarei Heads, under stones, *Corallina*, -/5/63 (W.F.P.); Smuggler's Bay, Whangarei Heads, under stones, -/5/63 (W.F.P.); Poor Knights Islands, under stones in pools, 4/4/64 (W.F.P.); Bream Tail, under stones, 12/8/63 (W.F.P.); Goat Island Bay, Leigh, under stones, *Carpophyllum* spp., 1962-64 (W.F.P.); Tryphena Bay, Great Barrier Island, 6 fathoms, A. W. B. Powell, 18/1/25 (D.M. and Powell Coll.); Tryphena Bay, Great Barrier Island, -/1/51 (Hipkins Coll.); Tawharanui Point, North and South sides, under stones, 31/12/63 (W.F.P.); Waiwera, *Carpophyllum* spp., under stones, 16/2/64 (W.F.P.); Brown's Bay, Auckland, brown algae, 19/1/64 (W.F.P.); off Otata Island, Noises Group, West side, 4 fathoms, coarse shell sand, 15/5/63 (W.F.P.); off Takapuna, Auckland, 4-6 fathoms, Laws Coll. (A.M.); Takapuna, under stones, *Corallina*, brown algae, 1962-64 (W.F.P.); Narrow Neck, Auckland, brown algae, under stones, 1962-64 (W.F.P.); St. Heliers, Auckland, Finlay Coll. (A.M.); Stanley Point, Auckland Harbour, *Sargassum* (W.F.P.); off Wairoa Pt., Waiuku Channel, Manukau Harbour, 4 fathoms, S. Hulme (W.F.P.); Cornwallis, Manukau Harbour, *Corallina* and under stones, 7/1/62 (W.F.P.); Jackson's Bay, Coromandel, under stones, fine red algae, 30/3/64 (W.F.P.); Bowentown, Tauranga Harbour, under stones, -/5/63 (W.F.P.); Omokoroa, Tauranga Harbour, 31/8/58 (W.F.P.); Mount Maunganui, Tauranga, Finlay Coll. (A.M.); Tolaga Bay, shell sand, R. K. Dell, 28/11/50 (D.M.); Lyall Bay, Wellington, shell sand, 17/2/56 (W.F.P.); Island Bay, Wellington, *Cystophora* (W.F.P.); Titahi Bay, 1905 (D.M.); Titahi Bay, *Corallina*, 5/6/62, and shell sand, -/11/55 (W.F.P.); Paremata Harbour, 1957 (W.F.P.); Pukerua Bay, on algae holdfasts washed ashore, 18/6/60 (W.F.P.); between Pukerua Bay and Paekakariki, under stones, 30/10/57 (W.F.P.); Middle Bank, Kapiti Island, in moki stomach contents, 14/1/62 (W.F.P.); B.S. 129, Pelorus Sound, 25-30 fathoms, M.V. "Alert", W. H. Dawbin, 26/12/51 (D.M.); Manaroa Bay, Pelorus Sound, mussel scrapings, 28/12/58 (W.F.P.); Bluegum Point, Kenepuru Sound, under stones, -/1/58 (W.F.P.); Nelson Harbour (Powell Coll.); Tahunanui Beach, Nelson, shell sand (Powell Coll.); Taylor's Mistake, Bank's Peninsula, soft coralline algae, W. R. B. Oliver, 10/4/10 (D.M.); Lyttelton Harbour, shell sand, 14/12/56 (W.F.P.); East of Diamond Harbour, under stones, -/9/63 (W.F.P.); Foveaux Strait, oyster beds (W.F.P.); off Mouth of Halfmoon Bay, Stewart Island, 8 fathoms, clean algae, -/4/59 (Smith Coll.); 4 fathoms, Paterson Inlet, Stewart Island, algae, -/8/58 (Smith Coll.); 18 fathoms off Bravo Island, Paterson Inlet, in lump of worm tubes, 22/7/54 (Smith Coll.); Port Pegasus, Stewart Island, 5 fathoms, M.V. "Alert", W. H. Dawbin (D.M.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", W. H. Dawbin, 6/5/50 (D.M.); B.S. 137, off Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin, 8/1/52 (D.M.); B.S. 106, between Unnamed Island and Breaksea Sound, Dusky Sound, 20 fathoms, M.V. "Alert", W. H. Dawbin, 7/5/50 (D.M.); Doubtful Sound, 50 fathoms (W.F.P.); B.S. 107, Goal Passage, Doubtful Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 2/5/50 (D.M.); B.S. 109, Bligh Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.); Chatham Islands (D.M.); Chatham Islands Exped., Stat. 13, Owenga, 4-6 fathoms, M.V. "Alert", 27/1/54 (D.M.); Chatham Island Exped., Stat. 38, South of Little Mangere, 43 fathoms, M.V. "Alert", 2/2/58 (D.M.).

Distribution: The North and South Islands, Stewart Island and the Chatham Islands, from near low water to a few fathoms.

Ecology: *E.* (*D.*) *limbata* occupies a wide range of habitats, from silted harbours to exposed coasts. In the former habitat, as seen in Auckland Harbour, it is often the dominant micro-mollusc, living on brown algae, in *Corallina* and under stones. In more exposed situations it is usually restricted to living under stones, though the choice of substratum is rather variable according to the locality and the abundance of competing species. If other *Eatoniella* species are absent or rare, *E.* (*D.*) *limbata* occupies many substrata and is generally common, but if the area is suitable for other eatoniellids and rissoids, it is usually

uncommon or absent on all substrata except under clean stones, where it is frequently very abundant.

Eatoniella (Dardanula) minutocrassa n. sp. Plate 6, figs. 13-15.

Shell minute, rather thin shelled but with a thickened aperture, colour usually pinkish, smooth and shining. Spire short, about 3½ whorls. Whorls moderately convex, smooth. Protoconch not marked off, smooth. Colour purplish-pink in holotype, but variable, purplish to pink, yellowish-brown to grey. Sutures false-margined with a dark purplish band. Columella and umbilical area of base darker in colour. Aperture oval, angled above, columella produced below slightly and thickened. Peristome rather thick and heavy, except the thin middle part of outer lip, which is strongly retracted. A small depression indicates border of umbilical chink which is hidden by inner lip. A narrow, colourless, transparent zone behind outer lip.

This species is readily distinguished from any other by its minute size, convex whorls, solid aperture and pinkish coloration.

Animal: (Island Bay, Wellington). Anterior lobe of foot long and mobile, sole with a mucous slit extending from centre of foot to posterior end. Tentacles very active, tapering. Snout short, bilobed. Colour yellowish. No opercular tentacles. Eyes remain beneath transparent edge of shell.

Operculum: (Fig. 14). (Leigh). Oval, curved, solid, yellow, semi-transparent. Muscle impression area extensive, yellowish-white, opaque. Peg short, broad, with a terminal flange. Marginal areas rather broad. Growth lines indistinct and a few faint spirals visible.

Radula: (Fig. 15). Typical of the subgenus. Central rather large, 2 + 1 + 2, lateral 2 + 1 + 2, with dorsal and ventral thickenings. Inner marginal with 3 cusps, outer marginal finely serrate, with a broad base. W.F.P. (A.M.).

Holotype: (Fig. 13). Goat Island Bay, Leigh, in *Corallina*, 1/1/64, W.F.P. (A.M.).

Height 0.925 mm. Width 0.6 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Great Island, Three Kings Islands, sublittoral algae, A. Baker (W.F.P.); N.Z.O.I. Stat., C. 760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, 18/2/62 (O.I.); Spirits Bay, shell sand (Hipkins Coll.); 22 fathoms, ½ mile West of Stephenson's Island, 3½ miles off Whangaroa, 29/12/53 (Hipkins Coll.); Taupo Bay, Whangaroa, shell sand, E. R. Richardson, 11/4/51 (D.M.) and 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.) and algae, 22/5/63 (W.F.P.); Smuggler's Bay, Whangarei Heads, short red algae, brown algae, coralline algae, 5/5/62 (W.F.P.); Taurikura Bay, Whangarei Heads, under stones, 15/5/61 (W.F.P.); Lort Point, Whangarei Heads, *Corallina*, -/5/62 (W.F.P.); Poor Knights Islands, under stones and vermetid masses, coralline algae, brown algae, 4/4/64 (W.F.P.); Goat Island Bay, Leigh, brown algae, *Corallina*, under stones, 1963-64 (W.F.P.); Tawharanui Point, North and South side, under stones, 31/12/63 (W.F.P.); Takapuna, Auckland, *Corallina* 1962-64 (W.F.P.); Campbells Bay, Auckland, *Caulerpa*, W. Ballantine (W.F.P.); Cornwallis, Manukau Harbour, silted *Corallina*, 7/1/62 (W.F.P.); 1 mile West

of Cornwallis, clean *Corallina*, 7/1/62 (W.F.P.); off Mayor Island, fish stomach contents, G. Williams (Powell Coll.); Tolaga Bay, R. K. Dell, 28/11/50 (D.M.); Island Bay, Wellington, algae, (D.M.) and algae, *Corallina*, 3/6/62, and shell sand, 2/10/56 (W.F.P.); Titahi Bay, shell sand, -/11/55 (W.F.P.); Titahi Bay, among paratypes of *E.* (*D.*) *roseocincta* (Suter) (D.M. and G.S.); East of Diamond Harbour, Lyttelton Harbour, under stones, -/9/63 (W.F.P.); Gollan's Bay, Lyttelton Harbour, brown algae, W. R. B. Oliver, 26/3/10 (D.M.); Chatham Island Exped., Port Hutt, Chatham Islands, shell sand, 8/2/54 (D.M.).

Distribution: The North Island, North East of the South Island, and the Chatham Islands, from the lower littoral zone to moderately deep water.

Ecology: Though *E.* (*D.*) *minutocrassus* prefers coralline and other short turf algae at low tide, it is also found under stones and on larger algae such as *Carpophyllum plumosum*. Though it is usually uncommon, it has been recorded as a dominant species in a few localities, notably the Poor Knights Islands.

Eatoniella (Dardanula) mortoni n. sp. Plate 7, figs. 16-20.

Shell solid, of medium size for the subgenus, conical, smooth. Spire usually rather short, a little taller than height of aperture in the holotype, but there is considerable variation. Whorls 4, lightly convex, fairly rapidly increasing; protoconch smooth, small, not marked off, body whorl large, but not swollen, periphery and base rounded. Aperture moderately large, approximately D-shaped in typical shells, but distinctly D-shaped in squat specimens (fig. 18), the anterior angulation typically indefinite; peristome continuous, thickened, inner lip broad, posterior part of outer lip especially heavy. Outer lip excavated strongly below. Colour variable, from dark grey, often with a purplish tint, to pale yellowish grey. Variation in shape is considerable, squat shells resembling *E.* (*D.*) *dilatata* (Powell), *E.* (*D.*) *latebricola* n. sp. and *E.* (*D.*) *fuscosubucula* n. sp. but can be separated on details of shape, colour and size. Tall shells resemble *E.* (*D.*) *olivacea,* but the new species can be distinguished by its rounded body whorl and apertural characters. Variation in the shell and the animal (see below) suggest that there may be more than one species included under this name.

Animal: (Leigh). Cephalic tentacles long, active, gradually tapering; eyes on outer bases of tentacles. Snout short, bilobed; buccal mass yellow to orange. Foot long, anterior mucous gland diffuse, posterior mucous gland large, dense white, opening into a slit extending from centre of sole to posterior end. Colour yellowish-white. Opercular lobe with no tentacle or group of mucous cells. (Island Bay) a short tentacle on left opercular lobe, and some black pigmentation on head and opercular lobes.

Operculum: (MacGregor's Bay). (Fig. 19). Oval, thick, strongly curved, peg broad, grooved. Muscle insertion area extensive, nearly opaque, pale brown on columella side, fading to yellowish near outer edge. Columella marginal area broad, yellowish transparent, outer marginal area similar but narrow. No internal ridge or thickening. Weak growth lines and fine spirals present.

Radula: (Fig., 20). Typical of the genus. Central large, 3 + 1 + 3, lateral with heavy basal processes, 2 + 1 + 2, inner marginal with 5 denticles and a cusp-like process on outer side just below the cutting edge. Outer marginal narrow, with a broad base and finely serrate.

Holotype: (Fig. 16). South side of Day's Bay, Wellington Harbour, on brown algae, 11/12/61 (W.F.P.) (A.M.).

Height 1.85 mm. Width 1.13 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, and the N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Spirits Bay, shell sand (Hipkins Coll.); Taupo Bay, Whangaroa, shell sand, 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, shell sand, -/1/55 (Hipkins Coll.); Poor Knights Islands, brown algae, 4/4/64 (W.F.P.); MacGregor's Bay, Whangarei Heads, algae, 22/5/63 (W.F.P.); Smuggler's Bay, Whangarei Heads, coralline algae, 6/5/62 (W.F.P.); Kaitoke, Great Barrier Island, short algae, 16/9/63 (W.F.P.); Jackson's Bay, Coromandel, *Carpophyllum plumosum*, 29/3/64 (W.F.P.); Stony Bay, Coromandel, *Corallina* and other short algae, 28/3/64 (W.F.P.); Lyall Bay, Wellington *Cystophora dumosa*, W. R. B. Oliver, 18/12/21 (D.M.); Island Bay, Wellington, algae, 3/6/62 (W.F.P.); Scorching Bay, Wellington, brown algae, 26/11/61 (W.F.P.); Owhiro Bay, Wellington, brown algae, 20/2/63 (W.F.P.); Taylor's Mistake, coralline algae, -/8/63 (W.F.P.) and W. R. B. Oliver, 10/4/10 (D.M.); East of Diamond Harbour, Lyttelton Harbour, -/8/63 (W.F.P.); Taieri Beach, Otago, Finlay Coll. (A.M.); Red Bluff, Chatham Islands, W. R. B. Oliver, 6/12/09 (D.M.); Tioriori, Chatham Islands, Dell Coll. (D.M.); Waitangi, Chatham Islands, pools between tides, W. R. B. Oliver, -/12/09 (D.M.).

Distribution: The East Coasts of the North and South Islands and the Chatham Islands, on algae at low tide.

I have much pleasure in naming this mollusc after Professor J. E. Morton, for his assistance during the course of this work.

Eatoniella (Dardanula) obtusispira (Powell). Plate 7, figs. 7-9.

1955 *Dardanula obtusispira* Powell; D.S.I.R. Bull. 15, Cape Exped. Series, p. 88, pl. 3, fig. 23.

1962 *Notosetia verecunda* Smith (not of Suter) (in part) Rec. Dom. Mus. 4 (5), p. 60, fig. 24.

This distinctive species is easily recognised by the solid, white shell, with a tall spire and blunt apex. The whorls are slightly convex, and the protoconch large and blunt. A small false umbilical chink is present. There is considerable variation in size (c.f. figs. 7 and 8) but the shape seems to remain fairly constant.

Animal: (Stewart Island). No pigmentation on exposed parts. (Dried specimen).

Operculum: (Fig. 9). Oval, yellowish, with an extensive, opaque muscle insertion area, though broken near the nucleus. Peg strong and grooved. Marginal area narrow. No internal ridge.

Radula: Unknown.

Holotype: (Fig. 7). Snares Islands, 50 fathoms (ex Finlay Coll.) (A.M.).

Height 2.2 mm. Width 1.4 mm.

Material Examined:

Holotypes and paratypes; 72 fathoms off Cape Saunders, Otago, Laws Coll. (A.M.); 50 fathoms, 10 miles E.N.E. Otago Heads, Finlay Coll. (A.M.); Bluff, Finlay Coll. (A.M.); Oyster bed, near Fairchild River, Foveaux Strait, 28/9/55 (Smith Coll.); Bathing Beach, Stewart Island (D.M.); off Mouth of Halfmoon Bay, 8 fathoms, clean sand, -/3/59 (Smith Coll.); off Poutama Island, South Cape,

Stewart Island, 30 fathoms, -/6/55 (Smith Coll.); 100 fathoms off Puyseger Point, South West Otago (D.M.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", W. H. Dawbin, 6/5/50 (D.M.); B.S. 110, entrance to George Sound, 15-20 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.).

Distribution: The South of the South Island, Stewart Island and the Snares Islands, in shallow to deep water.

Eatoniella (Dardanula) roseocincta (Suter). Plate 6, figs. 9-11.

1908 *Rissoa roseocincta* Suter, Proc. Mal. Soc. Lond. 8, p. 29, pl. 12, fig. 26.
1913 *Rissoa* (*Cingula*) *roseocincta* Suter; Suter, Man. N.Z. Moll. p. 209, pl. 12, fig. 17.
1915 *Estea roseocincta* Suter; Iredale, Trans. N.Z. Inst. 47, p. 454.
1927 *Dardanula roseocincta* Suter; Finlay, Trans. N.Z. Inst. 57, p. 378.
1959 *Dardanula roseocincta* Suter; Boreham, N.Z. Geol. Surv. Pal. Bull. 30, p. 37.

E. (*D.*) *roseocincta* exists in two forms. The typical form, which is found throughout the North Island, is a small, thin shell with weakly convex whorls. The body whorl is a little swollen and the aperture has a distinct inner lip which is slightly separated from the body whorl by a groove and a prominent umbilical chink which opens into a very minute umbilicus. The outer lip is thickened above and strongly excavated. The colour pattern is distinctive as there is a bright pink band above and below the sutures, the former continuing as a broad band around the periphery to the outer lip. Another pink area surrounds the umbilicus and the rest of the shell is very pale pink or white. The second form which is found in the far North and North East of the North Island, has a more solid shell which is uniform rose and has a heavier aperture. The umbilical chink is absent or very small, but a groove still separates the inner lip from the body whorl. This form is usually called *Dardanula roseola* in collections, but it differs from that species in being much smaller. The animal of this latter form is unknown and it may prove to be distinct. They are not subspecies, as both forms occur together in some localities.

Animal: (Three Kings, sublittoral algae). Unpigmented except for tracts of black on back of head and mantle roof. (Preserved material).

Operculum: Oval, thick, yellow, slightly curved, peg strong grooved; muscle insertion area extensive. A very indistinct thickening, corresponding to the internal ridge of some species, present. Marginal areas narrow.

Radula: Radula sac long, coiled. Typical of genus. Central large, cusps 3 + 1 + 3. Lateral, cusps large 2 + 1 + 2, thickened ridges above and below. Inner marginal with 3 cusps, outer finely serrate, with a broad base.

Lectotype: Titahi Bay, Cook Strait, Coll. M. Mestayer (G.S.).

Paralectotype: (Fig. 9). Height 1.35 mm. Width 0.775 mm.

Material Examined:

Paralectotypes; Three Kings, sublittoral algae, A. Baker (W.F.P.) (typical form); Spirits Bay, shell sand (Hipkins Coll.) (typical and atypical); Cape Maria van Diemen, shell sand (W.F.P.) (atypical); Doubtless Bay, 12 fathoms, Finlay Coll. (A.M.) (typical and atypical); Awanui Bay, 12 fathoms (Powell Coll.) (atypical); Taupo Bay, Whangaroa, shell sand, E. R. Richardson (D.M.) (atypical); Poor Knights Islands, 4/4/64 (W.F.P.) (atypical); Smuggler's Bay, Whangarei Heads, shell sand, 6/5/62 (W.F.P.) (typical); Mokohinau Islands (W.F.P.) (atypical); Lyall Bay, Wellington, Finlay Coll. (A.M.) (typical); Island Bay, Wellington, shell sand, 2/10/56 (W.F.P.) (typical); Titahi Bay, shell

sand, -/11/55 and 5/6/62 (W.F.P.) (typical); off Middle Bank Kapiti Island, in moki stomach contents, 14/1/62 (W.F.P.) (typical).

Distribution: The North Island, East and West Coasts, probably restricted to sublittoral algae.

Eatoniella (Dardanula) roseola (Iredale). Plate 6, figs. 1-8.

1873 *Rissoa rosea* Hutton, Cat. Mar. Moll., p. 29.
1880. *Barleeia rosea* (Hutton); Hutton Man. N.Z. Moll. p. 81.
1887 *Barleeia rosea* (Hutton); Tryon, Man. Conch. (1), 9, p. 393, pl. 71, fig. 6.
1898 *Barleeia rosea* (Hutton); Suter, Proc. Mal. Soc., 3, p. 8.
1909 *Rissoa (Cingula) rosea* Hutton; Suter, Subant. Is. N.Z., 1, p. 17.
1913 *Rissoa (Cingula) rosea,* Hutton; Suter, Man. N.Z. Moll., p. 209, pl. 12, fig. 16.
1915 *Estea roseola* Iredale, nom. nov. for *R. rosea* Hutton non Deshayes, 1862, Trans. N.Z. Inst., 47, p. 453.
1924 *Rissoa roseola* Iredale; Odhner, N.Z. Moll. Pap., Mortensen Pacific Exped., p. 21.
1927 *Dardanula roseola* Iredale; Finlay, Trans. N.Z. Inst., 57, p. 378.
1955 *Dardanula roseola* Iredale; Powell, D.S.I.R., Cape Exped. Series Bull. 15, p. 88.
1955 *Dardanula roseola lacteola* Powell, D.S.I.R., Cape Exped. Series Bull. 15, p. 88, pl. 3, fig. 25.

Though the holotype of *E.* (*D.*) *roseola* is a very badly broken shell, the distinctive colour and shape are unmistakable. The species is of intermediate size for the sub-genus, with a solid shell, having a tall spire, straight outlines, nearly flat whorls, an angled periphery, and a sharp apex. The peristome is moderately thickened and the outer lip only slightly retracted. The colour is typically bright pink, but the shell may be white or banded with pink.

Considerable variation exists within, and between, populations. Typical shells (figs. 2, 5) are solid, relatively large and of a uniform bright pink colour. Northern shells are usually somewhat smaller, with more convex whorls and frequently develop distinct bands of pink, the rest of the shell, including the base, being white (fig. 6). Fiordland specimens show considerable variation (figs. 1, 1a, 1b), samples from Bligh Sound being particularly variable—small squat shells with convex whorls and large normal-looking shells occur together, and these may, or may not, develop colour bands. A population of small, very pale pink shells with a pink band below the periphery of the body whorl, occurs off Puysegur Point, South West Otago. The base is rounded, the whorls convex and the sutures margined.

Powell's "subspecies", *lacteola,* is a large, white variant of *roseola.* The holotype of *lacteola* is a large shell for the species (height 2.265 mm.) but most of the paratypes are of normal size. Large shells are also found in other localities, fig. 3 being a large, pale pink shell from Bluff. Pink shells also occur at the Auckland Islands (fig. 2), the type locality for *lacteola.* White shells are found in samples taken throughout most of New Zealand, though these are generally from deepwater.

Animal: (Whangarei Heads). (Fig. 7). Cephalic tentacles tapering, active, smooth; snout bilobed, short. Foot long, slightly rounded anteriorly, rounded posteriorly, a mucous slit from centre of sole to posterior end. A single opercular tentacle on left side. Colour uniform pale yellowish-white.

Operculum: (Paterson Inlet, Stewart Island). (Fig. 8). Oval, nearly flat, yellow, with a weak internal ridge, faint spiral sculpture and weak

growth lines. Marginal area narrow. Muscle impression area indistinct but extensive, semi-transparent, not broken except near nucleus. Peg strong, grooved.

Radula: Similar to *E.* (*D.*) *olivacea* (Hutton). Central 2 + 1 + 2, lateral 2 + 1 + 2, inner marginal with 3 cusps, outer finely serrate.

Holotype: Stewart Island (D.M.) (broken). The dimensions of a specimen from Stewart Island (fig. 5) are given as typical dimensions for the species.

Height 1.93 mm. Width 1.14 mm.

Material Examined:

Holotype; N.Z.O.I., Stat. C. 760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.); 8 fathoms between Cape Maria van Diemen and mainland, -/2/61 (Hipkins Coll.); Spirits Bay, shell sand (Hipkins Coll.); Cape Maria van Diemen, shell sand (W.F.P.); Taupo Bay, Whangaroa, shell sand (Hipkins Coll.); 22 fathoms, ½ mile West of Stephenson's Island, off Whangaroa, 29/12/53 (Hipkins Coll.), Tapeka Point, Russell, shell sand, -/1/52 (Hipkins Coll.); 60 fathoms off Poor Knights Islands, Finlay Coll. (A.M.); Smuggler's Bay, Whangarei Heads, shell sand, 6/5/62 (W.F.P.); Taurikura Bay, Whangarei Heads, main channel in *Glycymeris* community, 7/5/63 (W.F.P.); Tryphena Bay, Great Barrier Island, shell sand, -/1/51 (Hipkins Coll.); off Emu Rock, Motuihe Channel, Hauraki Gulf, 8 fathoms, *Tawera* community (W.F.P.); off Mayor Island, in fish stomach contents, G. Williams (Powell Coll.); B.S. 173, Kapiti Channel, Cook Strait, 40° 52.2' S., 174° 57.2' E., 33 fathoms, M.V. "Alert", 30/8/51 (D.M.); Timaru, W. R. B. Oliver, -/2/07 (D.M.); Portobello, Dunedin Harbour, soft red algae, 3/9/63 (W.F.P.); 50 fathoms, 10 miles E.N.E. of Otago Heads (Powell Coll.); 60 fathoms, Otago Heads, Finlay Coll. (A.M.); 40-50 fathoms, Cape Saunders, Otago, Laws Coll. (A.M.); B.S. 190, 45° 45.4' S., 171° 5' E., off East Otago Coast, Canyon "B", 800 fathoms, M.V. "Alert", 16/8/55 (D.M.); Bluff, Finlay Coll. (A.M.); Oyster scrapings, Foveaux Strait, M. Spong (W.F.P.) and 1957 (W.F.P.); off Cape Island, South Cape, Stewart Island, 40-45 fathoms, in bryozoans and algae, -/1/55 (Smith Coll.); Glory Inlet, Stewart Island, 10-20 fathoms, -/1/57 (Smith Coll.); off Poutama Island, South Cape, Stewart Island, 30 fathoms, -/6/55 (Smith Coll.); Port Pegasus, Stewart Island, 18 fathoms (A.M.); off mouth of Halfmoon Bay, -/4/49, 8 fathoms, clean algae (Smith Coll.); Mason's Bay, Stewart Island, shell sand, O. Allan, -/8/48 (D.M.) and R. H. Harrison (A.M.); Bravo fishing ground, Patterson Inlet, Stewart Island, R. H. Traill, -/4/58 (Smith Coll.); Patterson Inlet, 8-10 fathoms, 19/4/54 (Smith Coll.); 100 fathoms, Puysegur Point, South West Otago (D.M.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", 6/5/50 (D.M.); Dusky Sound, 30 fathoms, R. Henry (D.M.); B.S. 106, between Breaksea and Unnamed Island, Dusky Sound, 20 fathoms, M.V. "Alert", W. H. Dawbin, 7/5/50 (D.M.); B.S. 137 off Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin (D.M.); 50 fathoms, Doubtful Sound (W.F.P.); B.S. 107, Goal Passage, Doubtful Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 8/5/50 (D.M.); Snares Islands, 50 fathoms (Powell Coll.); Auckland Islands, Finlay Coll. (A.M.); 6 fathoms, Carnley Harbour, Auckland Islands, Cape Expedition (Powell Coll.); Carnley Harbour, Auckland Islands, Cape Exped. (A.M.) and J. Sorensen, -/4/47 (D.M.); Faith Harbour, Auckland Island, beach drift (A.M.); 6 fathoms, Emergency Bay, C. A. Fleming, Cape Expedition (A.M.); Penguin Harbour, Campbell Island, 4 fathoms, R. L. Oliver, 5/8/44 (D.M.); Campbell Island, J. Sorensen (Powell Coll.); off Leeward Island, Antipodes, 15 fathoms, R. K. Dell, -/11/50 (D.M.); off East Cape, Antipodes Islands, 20 fathoms, R. K. Dell, -/11/50 (D.M.); 40-45 fathoms, and 50 fathoms, Bounty Islands (D.M.); 50 fathoms, Bounty Islands, Finlay Coll. (A.M.) and A. Hamilton (Powell Coll.); 170 fathoms, Bounty Islands, A. Hamilton Coll. (Powell Coll.); Mernoo Bank, 43° 21.5', 175° E., 52 fathoms (D.M.); Chatham Islands Exped. Stat. 38, South of Little Mangere, 43 fathoms, M.V. "Alert", 2/2/54 (D.M.); Chatham Island Exped. Stat. 23, 43° 32.5' S., 176° 47.5' W., North of the Sisters in 33 fathoms, M.V. "Alert", 29/1/54 (D.M.).

Distribution: The North and South Islands, Stewart Island, and the

Snares, Auckland, Campbell, Antipodes, Bounty and Chatham Islands, from low tide to moderately deep water, typically in a few fathoms, and most abundant in the South and Subantarctic.

Eatoniella (Dardanula) roseospira (Powell). Plate 6, fig. 12.

1936 *Dardanula roseospira* Powell, Discov. Rep. 15, p. 203, pl. 53, fig. 13.

This species appears to be typical of the *Dardanula* group in shell characters, but, as yet, the animal is unknown. A description is given below to facilitate identification.

Shell small, smooth, shining, elongate-conic. Whorls 4 to 4½, slightly convex, false margined with fine growth lines and spiral scratches; protoconch smooth, dome-shaped, not clearly marked off; periphery narrowly rounded. Aperture oval, with a slight posterior angulation; peristome thickened but not heavy; inner lip evenly concave, separated from body whorl below forming a chink which sometimes opens into a narrow umbilicus. Outer lip a little flanged and bent downwards posteriorly, slightly excavated below. Colour yellowish-brown or very pale pink, the first two whorls bright pink. Sometimes an indistinct white band in middle of body whorl. There is some variation in size and slight variation in colour.

Animal, operculum and radula unknown.

Holotype: Discovery Stat. 934, off Three Kings Islands, 92 metres (Brit. Mus.).

Height 1.4 mm. Width 0.95 mm. (from Powell)

Material Examined:

Paratypes (A.M.); N.Z.O.I. Stat. C. 760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.); 4 fathoms, between Cape Maria van Diemen and mainland, -/2/61 (Hipkins Coll.); Taupo Bay, shell sand, E. R. Richardson, 11/4/51 (D.M.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.).

Distribution: The far North and North East of the North Island, North of Whangarei.

Eatoniella (Dardanula) smithi n. sp. Plate 5, figs. 8, 9.

The shell is similar to that of *E.* (*D.*) *olivacea* (Hutton), but is usually taller, umbilicate, and of paler coloration. The aperture is round, with a rather thinner peristome than in *E.* (*D.*) *olivacea*. Whorls 5, nearly flat, sutures false margined with a white band. Colour varies from uniform dark purplish-grey to pure white. A thin dark band round edge of peristome, especially on outer lip, often developed. Except in darkly coloured specimens the shell colour is imparted by the yellowish-brown inner chitinous layer of the shell.

Animal: (Halfmoon Bay). The colour of the exposed parts is yellowish white, there being no trace of pigmentation as in *E.* (*D.*) *olivacea* (preserved material).

Operculum: (Fig. 9). Similar to that of *E.* (*D.*) *olivacea*. Oval, thick, curved, brownish, an irregular black patch on right and left ends, nucleus black. Peg flattened, grooved. Weak growth lines and fine spiral lines present. Muscle insertion area extensive. Marginal areas moderately wide, a very weak thickening in usual position for internal ridge.

Radula: Identical to that of *E.* (*D.*) *olivacea.*

Holotype: (Fig. 8). Halfmoon Bay, Stewart Island, -/9/47 (ex Smith Coll.) (A.M.).

Height 2.2 mm. Width 1.3 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt, E. Smith Coll.

Material Examined:

Holotype and paratypes; Foveaux Strait, oyster scrapings (W.F.P.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.); off mouth of Halfmoon Bay, Stewart Island, 8 fathoms, clean algae, -/4/59 (Smith Coll.); 4 fathoms, Patterson Inlet, Stewart Island, algae, -/8/58 (Smith Coll.); Patterson Inlet, Stewart Island, 8-10 fathoms, 19/4/54 (Smith Coll.); Port Pegasus, Stewart Island, M.V. "Alert", 23/11/47 (D.M.); Bravo Group, Patterson Inlet, low tide on algae, 1/7/51 (Smith Coll.); 30 fathoms off Poutama Island, South Cape, Stewart Island, -/6/55 (Smith Coll.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", W. H. Dawbin, 5/5/50 (D. M.); B.S. 137, Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin, 8/1/52 (D.M.); B.S. 106, between Unnamed Island and Breaksea, Dusky Sound, 20 fathoms, M.V. "Alert", W. H. Dawbin, 7/5/51 (D.M.); Doubtful Sound, 50 fathoms (W.F.P.); B.S. 110, inside entrance to George Sound, 15-20 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.); B.S. 109, Bligh Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.); Chatham Island Exped. Stat. 38, South of Little Mangere, 43 fathoms, 2/2/58, M.V. "Alert", (D.M.); Chatham Island Exped. Stat. 32, Waitangi, Chatham Islands, 7 fathoms, M.V. "Alert", 31/1/51 (D.M.); Chatham Islands Exped. Stat. 13, off Owenga, 4-6 fathoms, M.V. "Alert", 27/1/54 (D.M.).

Distribution: Foveaux Strait, Stewart Island, Fiordland, and the Chatham Islands, from low tide, on algae, to moderately deep water.

This species appears to replace *E.* (*D.*) *olivacea* at Stewart Island and can extend into deep water, a habitat not exploited by *E.* (*D.*) *olivacea.* At the Chatham Islands *E.* (*D.*) *smithi* appears to occur only in the sublittoral (dead shells only seen), while *E.* (*D.*) *olivacea* is the common littoral form.

Named in honour of Mrs E. Smith who has greatly advanced the study of the molluscan fauna of Stewart Island. Without her collection of Stewart Island eatoniellids at hand, much of this work would have been impossible.

Eatoniella (Dardanula) verecunda (Suter). **Plate 7, figs. 1, 2.**

1908 *Rissoa verecunda* Suter, Proc. Mal. Soc. London 8, p. 30, pl. 2, fig. 28.
1913 *Rissoa* (*Setia*) *verecunda* Suter; Suter, Man. N.Z. Moll., p. 216, pl. 13, fig. 4.
1915 *Notosetia verecunda* (Suter); Iredale, Trans. N.Z. Inst., 47, p. 454.
1933 *Notosetia verecunda* (Suter); Powell, Rec. Auck. Inst. Mus., 1 (4), p. 198, pl. 34, fig. 11 (lectotype).
1955 *Notosetia verecunda* (Suter); Powell, D.S.I.R. Cape Exped. Series, Bull. 15, p. 86.
1955 *Dardanula bollonsi* Powell, D.S.I.R. Bull. 15, Cape Exped. Series, p. 88, pl. 3, fig. 25.
1962 *Notosetia verecunda* (Suter); Smith, (in part) Rec. Dom. Mus. 4 (5), p. 60.

This species has previously been much confused. The lectotype is a dead, rather worn, broadly conical, white shell, of moderate size, with lightly convex whorls. The aperture is large and rounded, the inner lip being considerably thickened, especially posteriorly, and the columella being evenly and strongly convex. The outer lip is thin, except in the posterior corner, and strongly retracted. There is no umbilicus

E. (*D.*) *verecunda* resembles *E.* (*D.*) *fuscosubucula* n. sp., *E.* (*D.*) *latebricola* n. sp. and *E.* (*D.*) *dilatata* Powell, but can be separated by its larger size and heavy aperture.

Dardanula bollonsi Powell is a synonym. Not only is the shell identical with types of *E.* (*D.*) *verecunda,* but the type material of both was collected in the same dredging off the Snares Islands.

Animal, operculum and radula unknown.

Lectotype: (Fig. 1). 50 fathoms, off Snares Islands, (G.S.).
Height 1.75 mm. Width 1.13 mm.

Material Examined:

Lectotype, paralectotypes (G.S., D.M., A.M.); 50 fathoms, Snares Islands (D.M., A.M.) (and holotype and paratypes of *D. bollonsi*); 95 fathoms, Auckland Islands, Finlay Coll. (A.M.).

Distribution: The Snares and Auckland Islands in deep water.

Subgenus **Pellax** Finlay, 1927.

Type (o.d.): *Phasianella huttoni* Pilsbry, 1888.

Shell: Very large, ovate-conical, rather solid. Peristome thickened, aperture nearly circular.

Animal: Dark red, opercular lobes with a tentacle on each, right with a group of mucous cells at base of tentacle.

Operculum: Muscle insertion area extensive, red, no internal ridge.

Radula: As described for *E.* (*P.*) *huttoni.* The broad inner marginal with its 4 blunt cusps is the most unusual feature.

Eatoniella (Pellax) huttoni (Pilsbry). Plate 11, figs. 8-11.

1878 *Rissoa flammulata* Hutton, Journ. de Conch. p. 28.
1880 *Barleeia flammulata* (Hutton); Hutton, Man. N.Z. Moll. p. 81.
1888 *Phasianella huttoni* Pilsbry, Man. Conch. 10, p. 74.
1913 *Phasianella* (*Tricolia*) *huttoni* Pilsbry; Suter, Man. N.Z. Moll. p. 169, pl. 34, fig. 12.
1927 *Pellax huttoni* (Pilsbry); Finlay, Trans. N.Z. Inst. p. 368.

This relatively large, handsome species is the largest of the family. It has a distinctive shell, which is pink with white markings giving it a superficial similarity to the phasianellids, with which it was classified. The tall, conical, spire is composed of about six slightly convex whorls, including a smooth, dome-shaped protoconch which is not distinctly terminated. The aperture is moderately large, nearly circular, with a continuous, thickened, white peristome. The inner lip is concave, the outer fairly strongly excavated with a blunt edge. The bright rose-pink shell is sometimes of a uniform colour, but usually there are white zig-zag broad rays and narrow intermediate white or pale pink rays, though the base is always uniform pink and the aperture white. A greenish coloration is often apparent in fresh shells, but this is due to the bright green mantle.

Animal: (Fig. 9). Cephalic tentacles long, tapering, not as active as in other species of *Eatoniella;* eyes on prominent swellings at outer bases of tentacles. Snout short, bilobed. Foot with a very prominent slit in posterior half of sole. Opercular lobes each with a short, colourless

tentacle; a group of large glandular cells near right tentacle. Colour of sides of foot and snout deep red-brown to nearly scarlet, terminal part of snout, tentacles and sole white. Whole exposed animal highly irridescent.

The anatomy of this species is described in a forthcoming publication (Ponder,—a).

Operculum: (Fig. 10). Oval, nearly flat, rather thin, edges yellowish, semi-transparent. Muscle insertion area extensive, opaque, dark reddish on columella side, fading to yellow on outer side. Peg long, slender, curved to right. No internal ridge. Only faint growth lines visible.

Radula: (Fig. 11). Typical of the genus. Central large 3 + 1 + 3, the outermost cusp very small. Lateral rather small, 1 + 1 + 2, with ventral and dorsal thickenings. Inner marginal broad, with 4 weak, blunt cusps. Outer marginal finely serrate, with a broad base.

Holotype: Auckland. (Otago Museum, Dunedin).
Height 6.75 mm. Width 3.75 mm. (from Suter).

Material Examined:

N.Z.O.I. Stat. C. 760 off Three Kings Islands, 34° 10.8' S., 172° 8.4' E., 44 fathoms, 18/2/62 (O.I.); Spirits Bay, shell sand (Hipkins Coll.); 4 fathoms between Cape Maria van Diemen and mainland, -/2/61 (Hipkins Coll.); MacGregor's Bay, shell sand, 9/4/55 (Hipkins Coll.); Bream Tail, *Carpophyllum plumosum* in pools, 21/8/63 (W.F.P.); Goat Island Bay, Leigh, shell sand, 1/1/64 (W.F.P.); Tawharanui Point, North side, *Carpophyllum plumosum* and other browns in pools on papa platform, 31/12/63 (W.F.P.); Jackson's Bay, Coromandel, *Carpophyllum plumosum* in pools on papa platform, 29/3/64 (W.F.P.); Sandy Bay, Coromandel, *Carpophyllum* in pools, sublittoral algae, 30/3/64 (W.F.P.); off Mayor Island, fish stomach contents, G. Williams (Powell Coll.).

Distribution: The North and North East Coast of the North Island living on brown algae. A rather rare species.

Genus **CRASSITONIELLA** n. gen.

Type: *C. carinata* n. sp.

Shell: Solid, ovate-conical, peristome thick and heavy. Sculpture absent or a weak, single, peripheral cord. Colour orange, sometimes with white markings.

Animal: Similar to that of *Eatoniella,* but no opercular tentacles.

Operculum: Broad, with strong internal ridge. Muscle insertion area not differentiated, transparent. Columella margin strongly convex.

Radula: As described for *C. carinata.*

Crassitoniella carinata n. sp. Plate 10, figs. 2-5.

The shell is similar to the Australian *C. flammea* (frauenfeld) (Pl. 10, fig. 1), but differs in the presence of a weak, but distinct, peripheral cord and a uniform colour. Other details as in the Australian species. The species is easily identified by its orange-red colour and solid shell with a wide, blunt protoconch.

Animal: (Coromandel). (Fig. 3). External coloration largely pinkish-white, cephalic tentacles white and snout yellowish. Cephalic tentacles are long, active, slightly tapering; eyes large, on swellings at outer bases

of tentacles. Snout bilobed ventrally, rather short, buccal mass bright yellow. Foot broad, a mucous slit in posterior half of sole, posterior mucous gland large, dense white, bilobed. No opercular tentacles. Eyes normally visible through the transparent, colourless edge of the otherwise opaque shell.

Operculum: (Fig. 4). Pyriform, strongly curved, yellowish, semi-transparent, rather thin. Internal ridge very strong, wide. Peg rather long, straight, slightly oblique, with a thin terminal flange. No clearly marked muscle-insertion area. Area on columella side of internal ridge rather strongly bent inwards, a slightly thickened line runs longitudinally along the middle of this area. A thickened, short ridge on left end edge.

Radula: (Fig. 5). Moderately long, the teeth small. Central very large, lateral cusps small, 1 + 1 + 1, a pair of lateral thickenings, and 3 pairs of basal processes. Lateral small, slightly curved, cusps 1 + 1 + 1. Inner marginal slightly larger than lateral, simple except for blunt process on inner side. Outer marginal small, with 3 denticles, the apex curved.

Holotype: (Fig. 3). Spirits Bay, shell sand, -/4/51 (ex Hipkins Coll.) (A.M.).

Height 1.91 mm. Width 1.3 mm.

Paratypes: Auckland, and Dominion Museums, N.Z. Geological Survey, Lower Hutt, K. Hipkins Collection.

Material Examined:

Holotypes and paratypes; Taupo Bay, Whangaroa, E. R. Richardson, shell sand, 11/4/51 (D.M.); Taupo Bay, 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, shell sand, -/1/52 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); Smuggler's Bay, Whangarei Heads, shell sand, 6/5/62 (W.F.P.); Mokohinau Islands (W.F.P.); East of Jackson's Bay, Coromandel, on *Carpophyllum* in pool, 29/3/64 (W.F.P.).

Distribution: North East of the North Island, living on algae, but rare.

Genus LIRATONIELLA n. gen.

Type: *L. bicarinata* n. sp.

Shell: Solid, with a few, strong, spiral keels. Aperture nearly circular, peristome not much thickened.

Animal: Details not known.

Operculum: Broad, muscle insertion area opaque, extensive, columella margin rather convex.

Radula: As described for *L. bicarinata*.

Liratoniella bicarinata n. sp. Plate 11, figs. 1-3.

Shell of moderate size for the family, white, with a dark red inner chitinous layer showing through, solid yet semi-transparent, with two heavy spiral keels on each whorl. Protoconch sharply angled, a weak cord on edge of angle, rather flat on top, not distinctly marked off. Whorls 4, two strong spiral cords on each whorl, one cord just below suture, other just above, with suture in a narrow groove between them. A flat space between cords, raised higher than sutural groove, and

smooth except for slightly oblique, fine growth lines. A strong spiral cord on base emerging at junction of outer lip with inner lip. Just behind outer lip there are only weak spirals. Aperture nearly circular, columella strongly excavated, thin; peristome continuous, sharp. Outer lip bent downwards in posterior corner and reflected slightly. Last half of body whorl with no chitinous layer and therefore pure white.

Animal: Unpigmented, cephalic tentacles in preserved animal appear to be dorso-ventrally flattened and rather short. Eyes large and on outer bases of tentacles. Snout short, distinctly bilobed. A long slit in posterior half of sole. Male aphallic (preserved material).

Operculum: (Fig. 2). Broadly oval, curved, the columella edge expanded so that the peg hardly projects over it. Left end transparent, yellow-brown in colour. The muscle insertion area dense, extensive. Marginal area rather narrow. Peg curved, grooved. No sculpture apart from weak growth lines. Colour light brown.

In shape this operculum closely resembles that of the superficially similar *"Estea" crassicordata* Powell (see Ponder,—c) but their radulae are totally different.

Radula: (Fig. 3). Typical of family. Central rather large, the cusps small 2 + 1 + 2. Lateral small, 1 + 2 + 1, with a dorsal ridge and a weak ventral thickening. Inner marginal narrow, curved, with 3 cusps of similar size. Outer marginal finely serrate, with a broad basal area.

Holotype: (Fig. 1). N.Z.O.I. Stat. C. 760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substratum, 18/2/62 (O.I.).

Height: 1.975 mm. Width 1.26 mm.

Paratypes: New Zealand Oceanographic Institute, Auckland and Dominion Museums.

Material Examined: Holotype and paratypes.

Distribution: Off the Three Kings Islands.

Liratoniella crassicarinata (Powell). Plate 11, fig. 4.

1936 *Estea crassicarinata* Powell, Discov.Rep.,15,p.196,pl.53,fig.4.

This species is tentatively placed in *Lirotoniella* as it resembles *bicarinata* in most features. It differs from the type species in smaller size and uniform yellowish-brown colour, with the tip of the spire tinged with reddish-brown. There are four spiral keels on the penultimate whorl and above the periphery of the body whorl, and three on the base.

Animal, operculum and radula unknown.

Holotype: Discovery II Stat. 933, off the Three Kings Islands, 260 metres (Brit. Mus.).

Height 1.5 mm. Width 0.8 mm. (from Powell)

Material Examined:

Paratypes (Powell Coll.); Discovery II Stat. 932, off the Three Kings Islands, 185 metres (Powell Coll.); 100 fathoms off Big King Island, Three Kings Islands, Finlay Coll. (A.M.); Spirits Bay, shell sand, (Hipkins Coll.).

Distribution: The far North of the North Island in moderately deep water.

Genus **PUPATONIA** n. gen.

Type: *Estea minutula* Powell, 1933

Shell pupate, minute, white, solid; aperture ovate, peristome thickened, outer lip bent downwards at suture. Sculpture of fine, close, spiral lines. Imperforate.

Though superficially similar to *Microdryas* Laseron, *Pupatonia* differs in having a thicker shell, a different aperture, and less definite sculpture. Whereas *Microdryas* is related to the *Estea-Scrobs* group, *Pupatonia* is probably an eatoniellid.

Animal, radula and operculum unknown.

Pupatonia minutula (Powell). Plate 10, fig. 12.

1933 *Estea minutula* Powell, Rec. Cant. Mus. 4, p. 37, pl. 6, fig. 6.

This species can be recognised by its minute size, solid build and fine microscopic spiral striae. The aperture is solid and D-shaped. The inner lip being thick and broad, and the outer lip thickened within, but with a sharp edge, nearly straight except bent down a little above and produced forwards.

Holotype: (Fig. 12). 170 fathoms, Bounty Islands, Coll. Capt. Fairchild (Cant. Mus.).

Height 1.23 mm. Width 0.61 mm.

Material Examined:

Holotype and paratypes; Foveaux Strait, oyster dredgings (W.F.P.); Butterfield's Beach, Stewart Island, shell sand, O. Allan (D.M.); 50 fathoms, Snares Islands, Finlay Coll. (A.M.); 40-50 fathoms, Bounty Islands (D.M.); N.Z.O.I. Stat. A. 739, Bounty Islands, 49° 40.2' S., 178° 44.3' E., 60 fathoms (O.I.).

Distribution: Foveaux Strait, Stewart Island and the Snares and Bounty Islands.

Pupatonia atoma n. sp. Plate 10, fig. 15.

Shell very minute, solid, pupoid, white, imperforate. Whorls 4, protoconch dome-shaped, not marked off, smooth; whorls weakly convex, false margined, with distinct growth lines and very fine, irregular, spiral scratches. Body whorl not swollen, periphery and base rounded. Aperture oval, peristome thickened, especially in anterior and posterior corners. Columella thick, vertical, inner lip a little oblique above. Posterior corner of aperture thick and weakly angled. Outer lip bent down and produced forward slightly near suture, nearly straight below, edge sharp, thickened internally. Differs from other species of the genus in its smaller size. Animal, operculum and radula unknown.

Holotype: (Fig. 15). N.Z.O.I. Stat. A. 739, Bounty Islands, 49° 40.2' 178° 44.3' E., 60 fathoms (O.I.).

Height 0.8 mm. Width 0.4 mm.

Paratypes: N.Z. Oceanographic Institute, Auckland and Dominion Museums.

Material Examined:

Holotype and paratypes; 50 fathoms, Snares Islands, Finlay Coll. (A.M.); 170 fathoms off Puysegur Point, South West Otago (Powell Coll.).

Distribution: Off the South of the South Island, the Snares and Bounty Islands.

Pupatonia gracilispira (Powell). Plate 10, fig. 14.

1933 *Estea gracilispira* Powell, Rec. Auck. Mus. 1, p. 201, pl. 34, fig. 4.

This species differs from *P. minutula* in having a slightly narrower spire and in being smooth and polished. Animal, operculum and radula unknown.

Holotype: (Fig. 14). 10 fathoms off Owenga Beach, Chatham Islands.
Height 1.1 mm. Width 0.525 mm.

Material Examined: Holotype and paratypes.

Distribution: Chatham Islands.

Pupatonia pupinella (Finlay). Plate 10, fig. 13.

1905 *Rissoa leptalea* Murdoch; Trans. N.Z. Inst., 37; p. 228, figs. 23, 24.
1913 *Rissoa leptalea,* Murdoch, Suter, Man. N.Z. Moll. p. 213, pl. 12, fig. 22.
1927 *Notosetia pupinella* Finlay, (nom. nov. for *R. leptalea* Murdoch, 1905 non Verrill, 1885); Trans. N.Z. Inst. 57, p. 494.
1962 *Epigrus pupinella* (Finlay) Smith Rec. Dom. Mus. 4 (5), p. 61-62, fig. 3.

Smith (1962) has established Murdoch's type was collected in the Foveaux Strait area. The original type is missing and Smith has selected a neotype from Stewart Island which she figures.

The shell is distinctive with its tall cylindrical spire, dilated outer lip, and microscopic, dense spiral striae. The outer lip is bent slightly downwards posteriorly. Animal, radula and operculum unknown.

Neotype: Off Poutama Island, South Cape of Stewart Island, 30 fathoms, in bryozoan shell-sand (D.M.).
Height 1.85 mm. Width 0.59 mm. (from Smith)

Material Examined:
Topotypes; Bathing Beach, Stewart Island, shell sand, O. Allan, 1950 (D.M.).

Genus SKENELLA Martens and Pfeffer, 1886.

Type (monotypy): *S. georgiana* M. and P., 1886.

The single New Zealand species, *S. pfefferi Suter* 1909, agrees well with the type in shell characters. A short description of a shell of *S. pfefferi* from Kapiti Island, Cook Strait, is given below for comparison with related genera:—

Shell thin, yellowish brown, semi-transparent. Whorls 2½, convex, rapidly increasing; spire a depressed dome; protoconch smooth, not marked off; body whorl large, convex. Aperture large; peristome continuous, thin, inner lip a thin glaze across parietal wall; columella thin, near vertical; outer lip thin, strongly retracted below, produced forward posteriorly, with two prominent indentations in the middle region. Umbilicus broad, with strong growth lines, bordered by a sharp ridge. Sculpture of fine growth lines only.
Height 0.425 mm. Width 1.71 mm.

Animal: Typical of the family. Cephalic tentacles long and active, emerging from indentations in outer lip; eyes visible beneath the shell. Foot active, extensile, with a mucous slit in posterior half of sole. No pigmentation of exposed parts.

The eggs are very large and yolky, and the male has no penis.

Operculum: Oval, thin, slightly curved, nucleus very small, sunken; peg not heavy, grooved, connected to rest of operculum over nearly all

of its length. Columella marginal area moderately wide. Muscle insertion area not visible. Growth lines rather prominent.

Radula: Central very large, with two basal processes, 2 + 1 + 2, lateral small, long, 4 + 1 + 1, the outer two cusps large, the fifth largest. Inner marginal 3 + 1 + 1, the outer two cusps large, the fourth largest; outer marginal finely serrate, basal area wide.

S. pfefferi is distributed throughout New Zealand from the Three King Islands to Stewart Island and the Chatham Islands. It appears to be restricted to exposed coasts in the North, though it has not been found on the Auckland West Coast, but is generally more common in the South. It prefers large brown algae, on which it may be very abundant, but is also found on short algae, such as *Corallina*, in small numbers.

THE NEW ZEALAND SPECIES OF THE EATONIELLIDAE

The generic name last used follows in brackets.

Eatoniella Dall, 1876 (*Rissoa kerguelenensis* Smith, 1875)

(*Eatoniella*)
- *kerguelenensis chiltoni* (Suter, 1909) (*Dardanula*)
- *stewartiana* n. sp.

(*Abscindostoma*) n. subgen. (*Rissoina olivacea* var *lutea* Suter, 1908)
- *lutea* (Suter, 1908) (*Dardanula*)
- *albocolumella* n. sp.

(*Albitoniella*) n. subgen. (*Dardanula pallida* Powell, 1937)
- *pallida* (Powell, 1937) (*Dardanula*)
- *thola* n. sp.

(*Albosabula*) n. subgen. (*Rissoa lampra* Suter, 1908)
- *lampra* (Suter, 1908) (*Notosetia*)
- *poutama* (Smith, 1962) (*Zeradina*)
- *rakiura* n. sp.

(*Caveatoniella*) n. subgen. (*E.* (*C.*) *puniceomacer* n. sp.)
- *puniceomacer* n. sp.
- *perforata* n. sp.

(*Cerostraca*) Oliver, 1915 (*C. iredalei* Oliver, 1915)
- *bathami* n. sp.
- *delli* n. sp.
- *maculosa* n. sp.
- *tenella* (Powell, 1937) (*Dardanula*)

(*Dardaniopsis*) n. subgen. (*E.* (*D.*) *notalabia* n. sp.)
- *notalabia* n. sp.
- *globosa* n. sp.
- *pullmitra* n. sp.
- *varicolor* n. sp.
- ? *aterviisceralis* n. sp.

(*Dardanula*) Iredale, 1915 (*Dardania olivacea* Hutton, 1882).
- *olivacea* (Hutton, 1882) (*Dardanula*) (= *Dardanula olivacea annulata* (Hutton)
- *dilatata* (Powell, 1955) (*Notosetia*)
- *fossa* n. sp.
- *fuscosubucula* n. sp.
- *latebricola* n. sp.

limbata (Hutton, 1883) (*Dardanula*)
minutocrassa n. sp.
mortoni n. sp.
obtusispira (Powell, 1955) (*Dardanula*)
roseocincta (Suter, 1908) (*Dardanula*)
roseola (Iredale, 1915) (*Dardanula*) (= *Dardanula roseola lacteola* Powell)
roseospira (Powell, 1937) (*Dardanula*)
smithi n. sp.
verecunda (Suter, 1908) (*Notosetia*) (= *Dardanula bollonsi* Powell, 1955)
(*Pellax*) Finlay, 1927 (*Phasianella huttoni* Pilsbry, 1888)
huttoni (Pilsbry, 1888) (*Pellax*)
Crassitoniella n. gen. (*C. carinata* n. sp.)
carinata n. sp.
Liratoniella n. gen. (*L. bicarinata* n. sp.)
bicarinata n. sp.
crassicarinata (Powell, 1937) (*Estea*)
Pupatonia n. gen. (*Estea minutula* Powell, 1933)
minutula (Powell, 1933) (*Estea*)
atoma n. sp.
gracilispira (Powell, 1933) (*Estea*)
pupinella (*Epigrus*)
Skenella Martens and Pfeffer, 1886 (*S. georgiana* M. and P., 1886)
pfefferi Suter, 1909 (*Skenella*)

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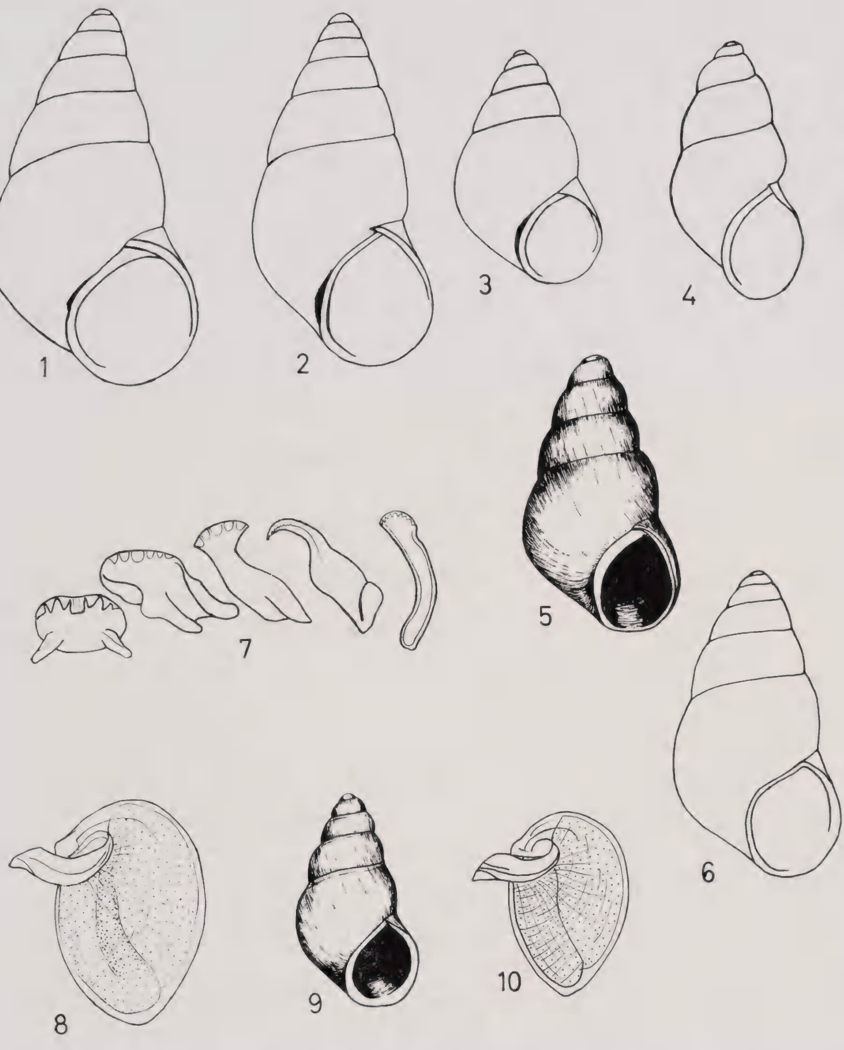


Eatoniella (*Eatoniella*) *kerguelenensis kerguelenensis* (Smith, 1875) ..

Fig. 1. Kerguelen Island, 3.5 x 1.95 mm.

Eatoniella (*Eatoniella*) *kerguelenensis chiltoni* Suter (1909)

Fig. 2. Chatham Islands, 3.26 x 1.67 mm.

3. Chatham Islands, 2.17 x 1.35.

4. Snares Islands, 2.41 x 1.8.

5. Holotype, 2.53 x 1.5 mm.

6. Dunedin Harbour, 2.83 x 1.55.

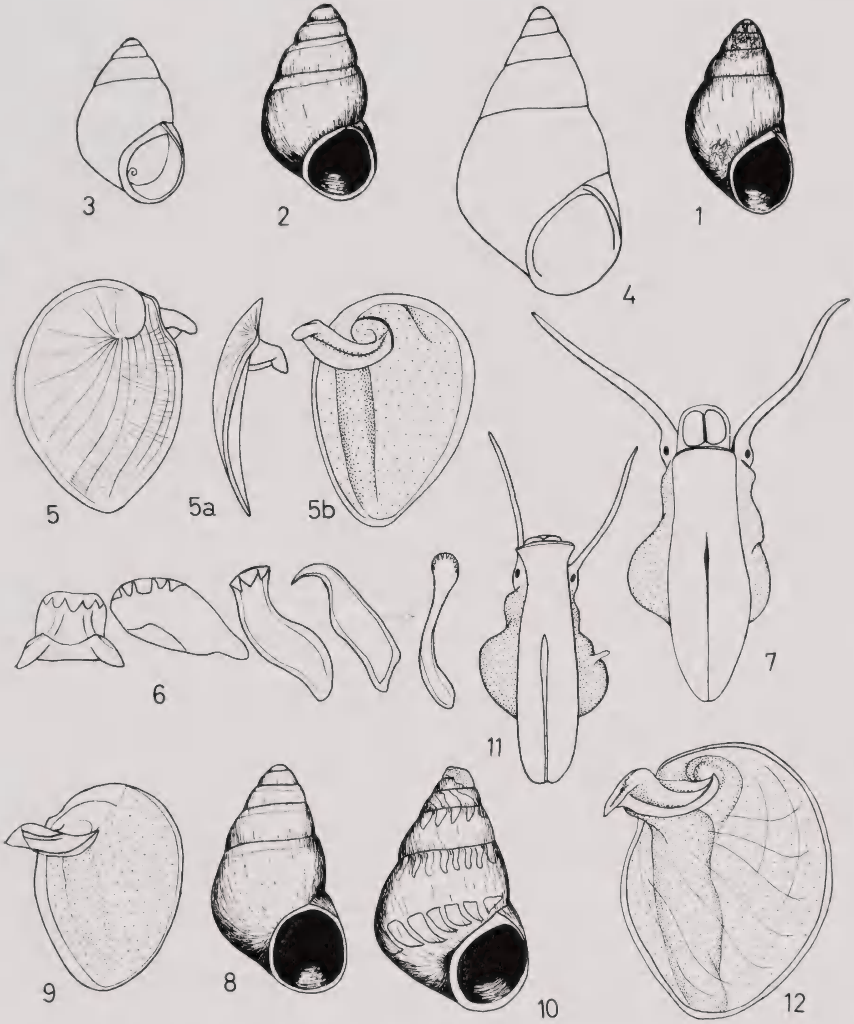
7. Radula.

8. Operculum (inner side).

Eatoniella (*Eatoniella*) *stewartiana* n. sp.

Fig. 9. Holotype, 2.0 x 1.15 mm.

10. Operculum (inner side).



Eatoniella (*Dardanula*) *olivacea* (Hutton, 1882)

Fig. 1. Lectotype, 1.88 x 1.01.

2. Lectotype of *olivacea* var. *annulata* Hutton 1.9 x 1.125 mm.

3. A specimen from the 'cotype' material in the Canterbury Museum, 1.6 x 1.0 mm.

4. Waiwera (large form), 2.8 x 1.575 mm.

5 a, b. Operculum (outer, lateral and inner sides).

6. Radula.

7. Animal (ventral view)

Eatoniella (*Dardanula*) *smithi* n. sp.

Fig. 8. Holotype 2.2 x 1.3 mm.

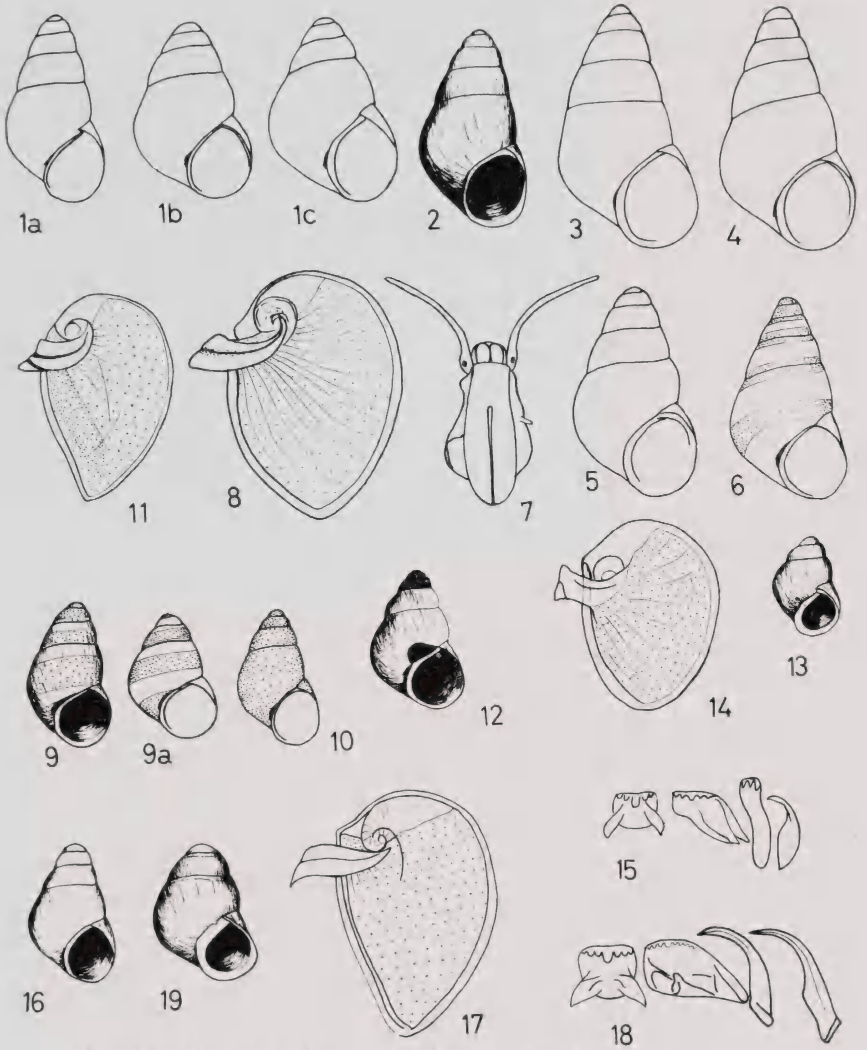
9. Operculum (inner side).

Eatoniella (*Dardanula*) *limbata* (Hutton, 1883)

10. Lectotype, 2.4 (estim.) x 1.5 mm.

11. Animal (ventral view).

12. Operculum (inner side).



Eatoniella (*Dardanula*) *roseola* (Iredale, 1915)
Fig. 1, a, b. Doubtful Sound, 50 fathoms, 1.73 x 0.9 mm.
(a) 1.65 x 1.1 mm. (b) 1.72 x 1.2 mm.
2. Auckland Islands, 1.85 x 1.00 mm.
3. Bluff (pale pink form) 1.85 x 1.275 mm.
4. Holotype of *Dardanula roseola lacteola* Powell 2.265 x 1.275 mm.
5. Stewart Island, 1.93 x 1.14 mm.
6. Tryphena Bay, Great Barrier Island 1.85 x 1.05 mm.
7. Animal (ventral view).
8. Operculum (inner side).

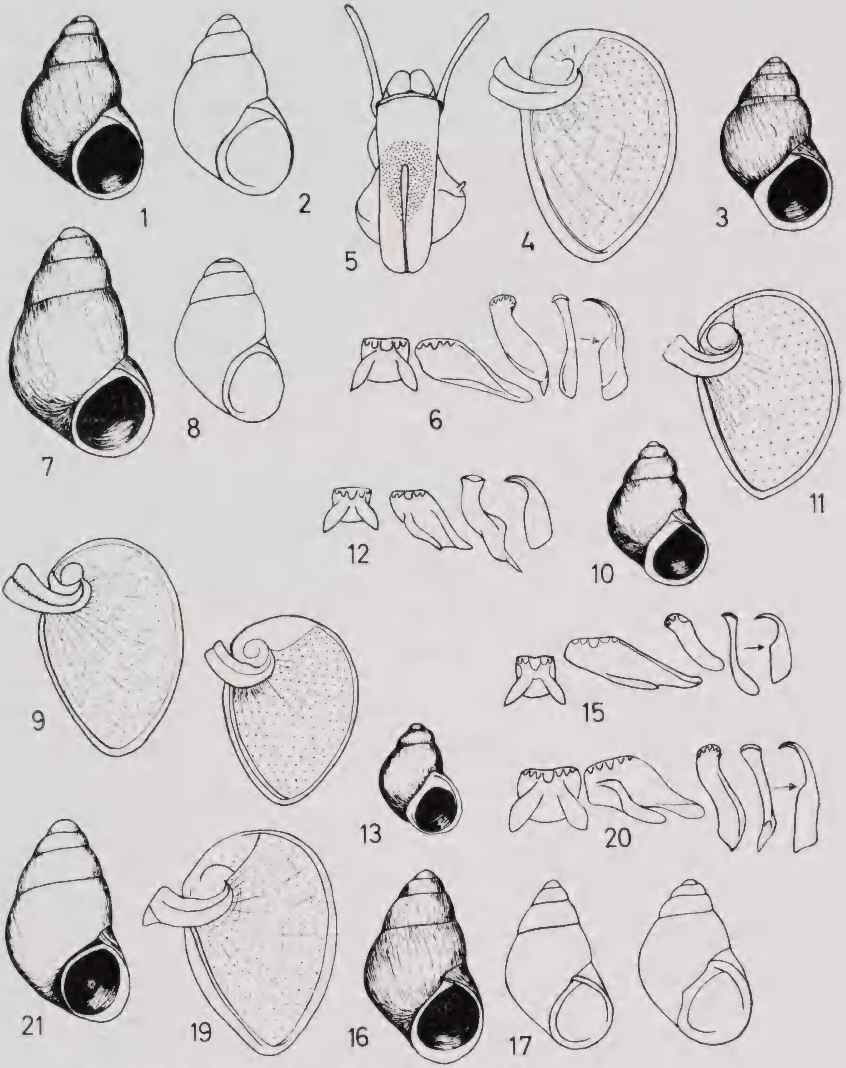
Eatoniella (*Dardanula*) *roseocincta* (Suter, 1908)
Fig. 9. a. Paratypes (9) 1.35 x 0.775 mm. (a) 1.15 x 0.8 mm.
10. Awanui Bay, 1.25 x 0.725 mm.
11. Operculum (inner side).

Eatoniella (*Dardanula*) *roseospira* (Powell, 1937)
Fig. 12. Paratype, 1.3 x 0.875 mm.

Eatoniella (*Dardanula*) *minutocrassa*, n. sp.
Fig. 13. Holotype, 0.925 x 0.6 mm.
14. Operculum (inner side).
15. Radula.

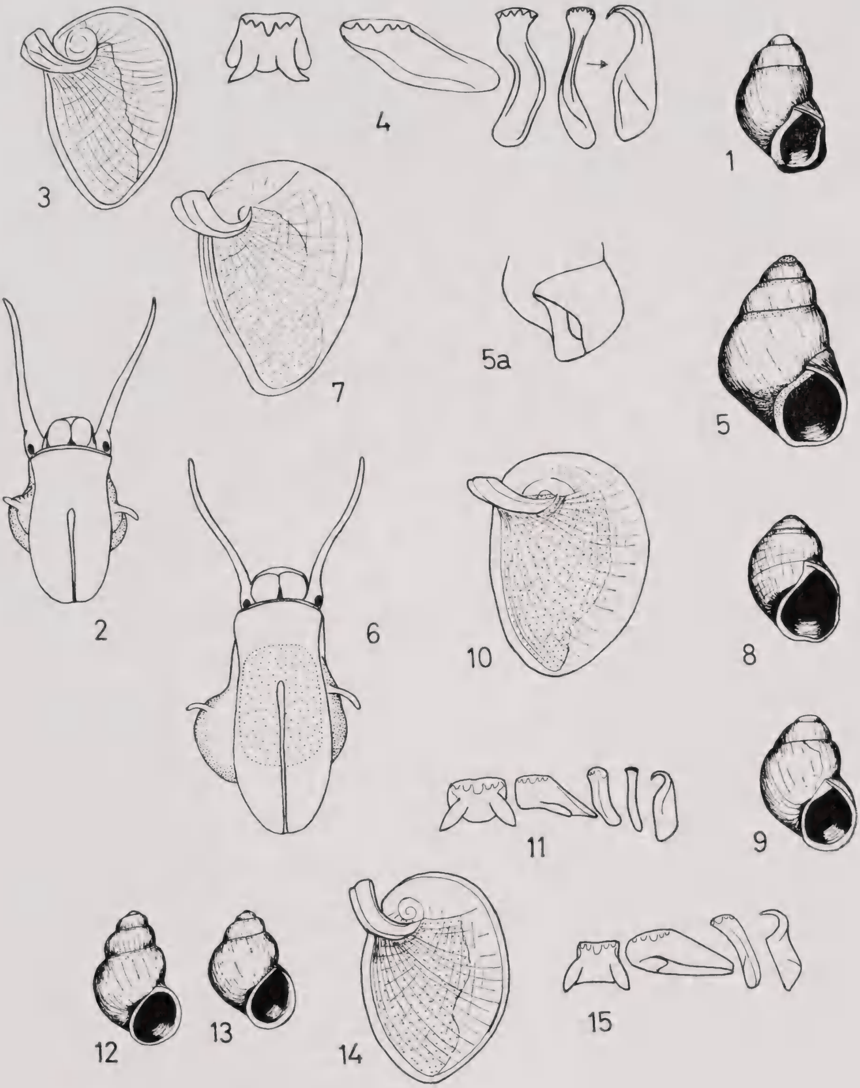
Eatoniella (*Albitoniella*) *pallida* (Powell, 1937)
Fig. 16. Paratype, 1.3 x 0.8 mm.
17. Operculum (inner side).
18. Radula.

Eatoniella (*Albitoniella*) *thola* n. sp.
Fig. 19. Holotype, 0.95 x 1.25 mm.



Eatoniella (*Dardanula*) *verecunda* (Suter, 1908)
Fig. 1. Lectotype 1.75 x 1.13 mm.
2. Holotype of *Dardanula bollonsi* Powell 2.71 x 1.125 mm.
Eatoniella (*Dardanula*) *latebricola* n. sp.
Fig. 3. Holotype, 1.65 x 1.05 mm. 4 Operculum (inner side).
5. Animal (ventral side). 6. Radula.
Eatoniella (*Dardanula*) *obtusispira* (Powell, 1955)
Fig. 7. Holotype, 2.2 x 1.4 mm.
8. Off Poutama Island, Stewart Island, 30 fathoms, 1.6 x 1.25 mm. 9. Operculum (inner side).
Eatoniella (*Dardanula*) *fuscosubucula* n. sp.
Fig. 10. Holotype, 1.4 x 0.95 mm. 11. Operculum (inner side).
12. Radula.
Eatoniella (*Dardanula*) *dilatata* (Powell, 1955)
Fig. 13. Holotype, 1.05 x 0.78 mm. 14. Operculum (inner side).
15. Radula.
Eatoniella (*Dardanula*) *mortoni* n. sp.
Fig. 16. Holotype, 1.85 x 1.13 mm.
17. MacGregor's Bay, Whangarei Heads, 1.625 x 1.025 mm.
18. Red Rocks, Wellington, under *Durvillea* holdfasts 1.6 x 1.1 mm.
19. Operculum (inner side). 20. Radula.
Eatoniella (*Dardanula*) *fossa* n. sp.
Fig. 21. Holotype, 1.9 x 1.2 mm.

PLATE 8



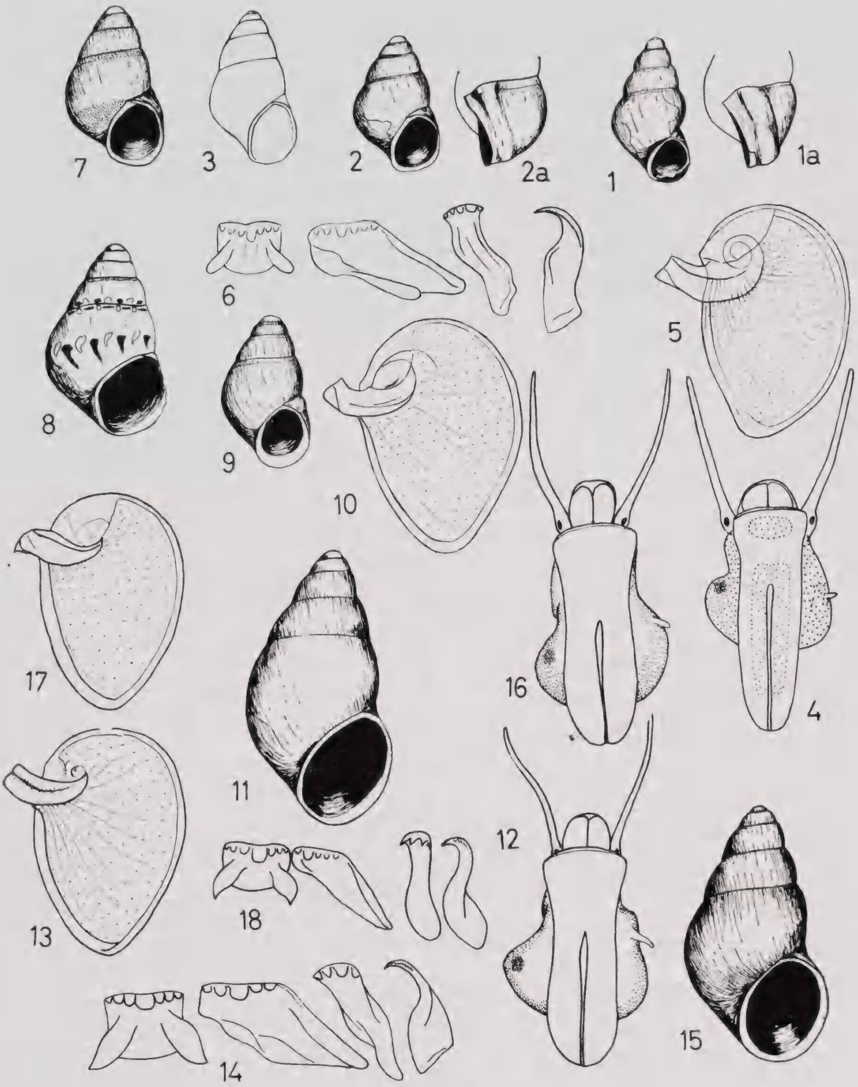
Eatoniella (*Dardaniopsis*) *notalabia* n. sp.
Fig. 1. Holotype, 1.26 x 0.8 mm.
2. Animal (ventral view).
3. Operculum (inner side).
4. Radula.

Eatoniella (*Dardaniopsis*) *varicolor* n. sp.
Fig. 5, a. Holotype, 1.73 x 1.13 mm.
6. Animal (ventral view).
7. Operculum (inner side).

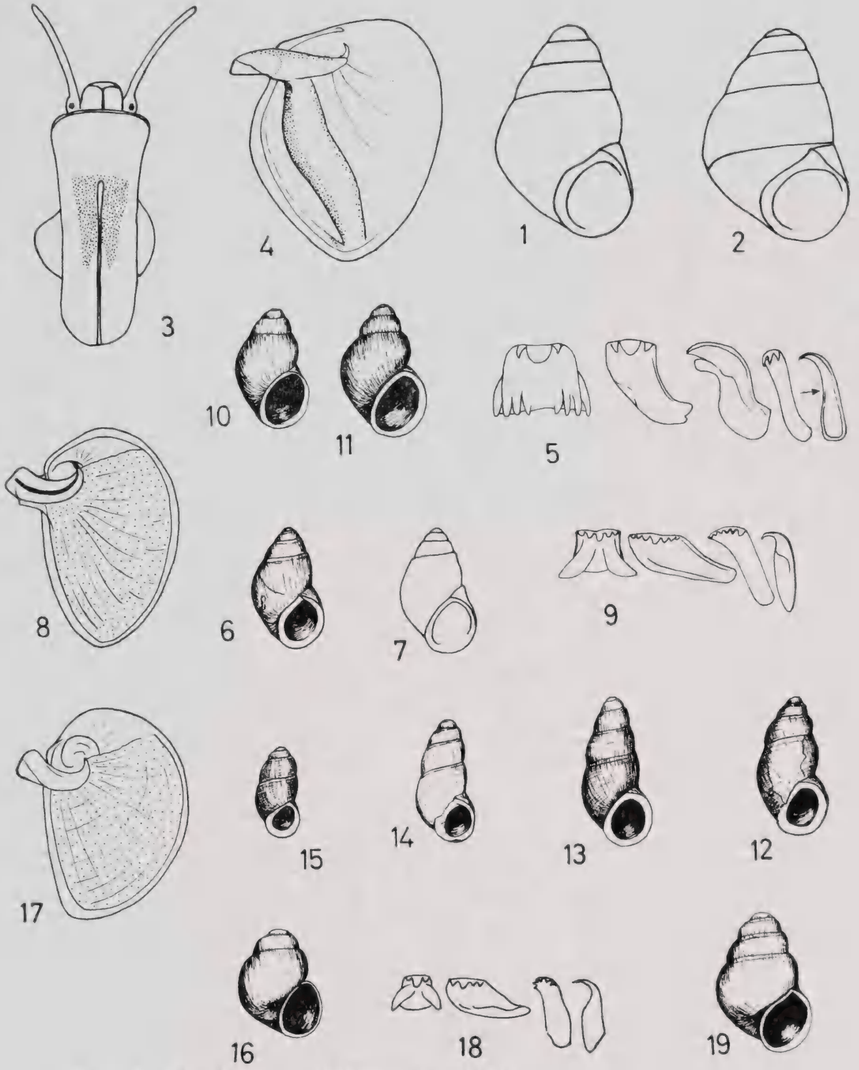
Eatoniella (*Dardaniopsis*) *globosa* n. sp.
Fig. 8. Holotype, 1.15 x 0.8 mm.

Eatoniella (*Dardaniopsis*) *pullmitra* n. sp.
Fig. 9. Holotype, 1.23 x 0.85 mm.
10. Operculum (inner side).
11. Radula.

Eatoniella (*Dardaniopsis?*) *atervisceralis* n. sp.
Fig. 12. Holotype, 1.23 x 0.75 mm.
13. Paratype (globose form) 1.07 x 0.75 mm.
14. Operculum (inner side).
15. Radula.

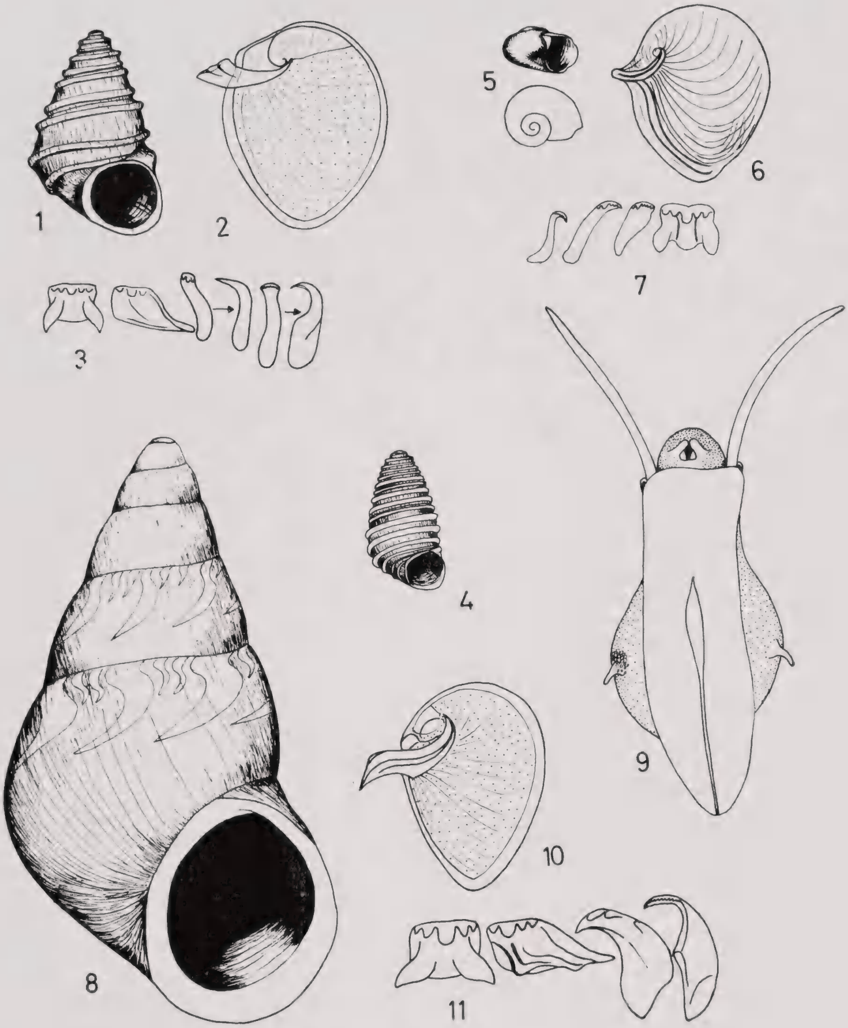


Eatoniella (*Cerostraca*) *iredalei* (Oliver, 1915)
Fig. 1, a. Holotype, 1.35 x 0.7 mm.
Eatoniella (*Cerostraca*) *delli* n. sp.
Fig. 2, a. Holotype 1.24 x 0.73 mm.
3. East of Purau, Lyttelton Harbour, 1.4 x 0.77 mm.
4. Animal (ventral view). 5. Operculum (inner side).
6. Radula.
Eatoniella (*Cerostraca*) *maculosa* n. sp.
Fig. 7. Holotype, 1.48 x 0.875 mm.
Eatoniella (*Cerostraca*) *tenella* (Powell, 1937)
Fig. 8. Paratype, 1.76 x 1.1 mm.
Eatoniella (*Cerostraca*) *bathami* n. sp.
Fig. 9. Holotype, 1.42 x 0.8 mm. 10. Operculum (inner side).
Eatoniella (*Abscindostoma*) *lutea* (Suter, 1908)
Fig. 11. Paralectotype, 2.53 x 1.36 mm.
12. Animal (ventral view). 13. Operculum (inner side).
14. Radula.
Eatoniella (*Abscindostoma*) *albocolumella* n. sp.
Fig. 15. Holotype, 2.37 x 1.35 mm.
16. Animal (ventral view).
17. Operculum (inner side). 18. Radula.



Crassitoniella flammea (Frauenfeld, 1867)
Fig. 1. Sydney, New South Wales, Australia, 1.91 x 1.25 mm.
Crassitoniella carinata n. sp.
Fig. 2. Holotype, 1.91 x 1.3 mm. 3. Animal (ventral view).
4. Operculum (inner side). 5. Radula.
Eatoniella (*Albosabula*) *lampra* (Suter, 1908)
Fig. 6. Paralectotype, 1.1 x 0.625 mm.
7. Groper Island, Paterson Inlet, Stewart Island. 1.125 x 0.66 mm.
8. Operculum (inner side). 9. Radula.
Eatoniella (*Albosabula*) *rakuria* n. sp.
Fig. 10. Holotype, 1.1 x 0.65 mm.
Eatoniella (*Albosabula*) *poutama* (Smith, 1962)
Fig. 11. Doubtful Sound, 50 fathoms, 1.2 x 0.78 mm.
Pupatonia minutula (Powell, 1933)
Fig. 12. Holotype, 1.23 x 0.61 mm.
Pupatonia pupinella (Finlay, 1927)
Fig. 13. Topotype, 1.35 x 0.625 mm.
Pupatonia gracilispira (Powell, 1933)
Fig. 14. Holotype, 1.1 x 0.525 mm.
Pupatonia atoma n. sp.
Fig. 15. Holotype, 0.8 x 0.4 mm.
Eatoniella (*Caveatoniella*) *puniceomacer* n. sp.
Fig. 16. Holotype, 0.95 x 0.73.
17. Operculum (innner side). 18. Radula.
Eatoniella (*Caveatoniella*) *perforata* n. sp.
Fig. 19. Holotype, 1.25 x 0.85 mm.

PLATE 11



Liratoniella bicarinata n. sp.

Fig. 1. Holotype, 1.975 x 1.26 mm.

2. Operculum (inner side).

3. Radula.

Liratoniella crassicarinata (Powell, 1937)

Fig. 4. Paratype, 1.35 x 0.71 mm.

Skenella pfefferi (Suter, 1909)

Fig. 5. Kapiti Island, 0.425 x 1.71 mm.

6. Operculum (inner side).

7. Radula.

Eatoniella (Pellax) huttoni (Pilsbry, 1888)

Fig. 8. Goat Island Bay, 6.0 x 3.15 mm.

9. Animal (ventral view).

10. Operculum inner side).

11. Radula.

A Revision of the New Zealand Recent Species Previously Known as Notosetia Iredale, 1915 (Rissoidae, Gastropoda)

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Zoology Department, University of Auckland

Abstract

The thirty recent New Zealand species previously classified in the genus *Notosetia* are reviewed. The revised classification of these species is based on a study of the animal, operculum and radula. The species are regrouped in three families and nine genera and subgenera. Five new species, three new genera, three new subgenera, and one new subfamily are described.

Introduction

The Rissoidae has long been a dumping ground for small featureless shells, which is one of the reasons for its unpopularity. There are certain genera that get more than their fair share of anomalous species, *Rissoa, Setia, Cingula* and *Barleeia* being some of the better known. The genus *Notosetia* has a large number of species ascribed to it in both New Zealand and Australia, and has proved to be a particularly heterogeneous group. Iredale (1915), as he named the genus, stated "I consider it to be a heterogeneous assemblage, but consider it wiser to provide quite a new name than encumber Neozelanic literature with another unnecessary extra-limital innovation." Unfortunately Iredale chose as the type, a species that is not even a rissoid, but a liotiid, a family in the Trochacea!

Iredale did not provide a generic description but later authors have included in the genus small featureless, white or coloured shells of simple outline, with a smooth or indistinctly sculptured surface. Examination of the operculae, radulae and animals of several species, has proved the heterogeneous nature of the group, the classification used here being built primarily on these characters.

Powell (1962) listed 31 species from New Zealand in his check list, but Smith (1962) added two new species, removed two by synonymy and *N. pupinella* Finlay was placed in *Epigrus*.

The majority of the species of *"Notosetia"* belong to a new genus related to the true rissoids. Four species are included in the Eatoniellidae (Ponder, 1965b) and six in the Cingulopsidae. Two species are included in *Rissoa* (*Haurakia*) (Rissoidae). The type and one other species belong to the Liotiidae. The terminology and method used in the descriptions of the animal, operculum and radula is the same as that used by Ponder (1965b).

Abbreviations

A.M.—Auckland Museum. Coll.—Collection. D.M.—Dominion Museum; G.S.—Geological Survey. O.I.—N.Z. Oceanographic Institute.

Rec. Auck. Inst. Mus. Vol. 6, No. 2, pp. 101-131, 15th Oct., 1965.

Family LIOTIIDAE

Genus NOTOSETIA Iredale, 1915

Type (o.d.): *Barleeia neozelanica* Suter, 1898

Shell small, ovate-conical, imperforate, white, thin, smooth, shining. Sculpture of fine, oblique growth lines and a few spiral striae around umbilical area. Protoconch small, globose, $1\frac{1}{2}$ smooth convex whorls, suture impressed, aperture angled above, peristome discontinuous, sharp, not much thickened within, columella vertical, slightly concave, callous; a thin callosity on the parietal wall. Outer lip excavated below. No posterior sinus and no external varix.

Operculum: Polygyrous, circular, thin, transparent, yellowish, margin rather irregular, about twelve closely spiralling revolutions.

Radula: Formula $\infty + 1 + 1 + 3 + 1 + 3 + 1 + 1 + \infty$ typically rhipidoglossan. Central with several long denticles, and is smallest tooth in row. Laterals with denticles of varying size and number, 1 to 3 having several long denticles, fourth with few, fifth finely serrate. Marginals numerous, long and slender, hook-like terminally.

Clearly a member of the Liotiidae, *Notosetia* is close to *Lissotesta*. The present investigation recognises only two species of this genus.

Notosetia neozelanica (Suter). **Pl. 12, figs. 10, 11; Pl. 13, figs. 1, 1a.**

1898 *Barleeia neozelanica* Suter, Proc. Mal. Soc. Lond. 3, p. 8, fig. 5.
1913 *Rissoa* (*Setia*) *neozelanica* (Suter); Suter, Man. N.Z. Moll., p. 214, pl. 13, fig. 1.
1915 *Notosetia neozelanica* (Suter); Iredale Trans. N.Z. Inst., 47, p. 452.
1933 *Notosetia neozelanica* (Suter); Powell, Rec. Auck. Inst. Mus. 1 (4), p. 197, pl. 34, fig. 10 (Lectotype).
1955 *Notosetia neozelanica* (Suter); Powell, D.S.I.R., Cape Exped. Series Bull., 15, p. 85.
1962 *Notosetia neozelanica* (Suter); Smith Rec. Dom. Mus. 4 (5), p. 57, fig. 12.

This species is very distinctive and shows little variation. Smith (1962) described and figured the tightly coiled operculum and remarked that it was "unusual for the genus." A figure of a paralectotype (fig. 1, 1a) is given for comparison with the other species discussed.

Animal: (Off Otago Heads). Unpigmented but other details unknown (dried material).

Operculum: (Fig. 10). As described for genus.

Radula: (Fig. 11). Central 10 denticles, smallest tooth in row. First, second and third laterals with about 8, 9 and 5-7 long denticles respectively, fourth with 3 blunt cusps and fifth with a straight row of fine serrations. Marginals numerous, long and slender, with hooked ends, progressively smaller towards outermost marginal.

Lectotype: Stewart Island, Suter collection (Geol. Surv.).

Height 2.0 mm. Width 1.5 mm (from Suter).

Material Examined:

Paralectotypes (G.S. and D.M.); 50 fathoms, off Oamaru, Finlay Coll. (A.M.); 60 fathoms, off Otago Heads, Finlay Collection (A.M.); B.S. 190, 45° 45.4' S., 171° 5' E., off East Otago Coast in 300 fathoms, M.V. "Alert", 16/8/55 (D.M.); 40-50 fathoms, off Cape Saunders, Otago, Laws Collection

(A.M.); Foveaux Strait, Finlay Collection (A.M.); 100 fathoms, Puysegur Point (D.M.); Middle Grounds, near Ruapuke Island, Foxeaux Strait, O. Allan, -/3/51 (D.M.); Stewart Island (Powell Coll. and D.M.); 50 fathoms, off Half-moon Bay, Stewart Island, -/10/54 (Gardner Coll.); Port Pegasus, Stewart Island, in 5 fathoms, 23/11/47, M.V. "Alert" (D.M.); 8-10 fathoms, Paterson Inlet, Stewart Island, 19/4/54, in algae (Smith Coll.); B.S. 141, immediately North of South Point, Kaipipi Bay, Paterson Inlet, M.V. "Alert", W. H. Dawbin, 12/1/52 (D.M.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", W. H. Dawbin, 6/5/50 (D.M.); B.S. 137, off Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin, 8/1/52 (D.M.); B.S. 106, between Unnamed Island and Breaksea, Dusky Sound, 20 fathoms, M.V. "Alert", W. H. Dawbin, 7/5/50 (D.M.); 107, Goal Passage, Doubtful Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 8/5/50 (D.M.); B.S. 110, inside entrance to George Sound, 15-20 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.); B.S. 109, Bligh Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.); Snares Island, 50 fathoms (A.M., Powell Coll., D.M.); Auckland Islands, Finlay Coll. (A.M.); 6 fathoms, Emergency Bay, Carnley Harbour, Auckland Islands, Cape Expedition (Powell Coll.); Carnley Harbour, Auckland Islands, J. Sorensen, -/4/47 (D.M.); Bounty Islands, 50 fathoms, Finlay Coll. (A.M. and Powell Coll.) and 40-45 fathoms (D.M.); off Leeward Island, Antipodes Islands, 15 fathoms, -/11/50, R. K. Dell (D.M.); Chatham Island Exped. Stat. 38, South of Little Mangere, 43 fathoms, M.V. "Alert", W. H. Dawbin, 2/2/54 (D.M.); Chatham Island Exped. Stat. 20, 43° 39' S., 176° 34.5' E., off Cape Young, 20 fathoms, 28/1/54, M.V. "Alert" (D.M.); Waitangi, Chatham Islands, shell sand, A. W. B. Powell, -/2/33 (A.M.); Chatham Island Exped. Stat. 23, 43° 32.5' S., 176° 47.5' E., North of the Sisters, 33 fathoms, 29/1/54, M.V. "Alert" (D.M.); Mernoo Bank, 43° 21' S., 175° E., 52 fathoms (D.M.); R.R.S. Discovery II Stat. 2772, Discovery Bank, 140 metres, 1/12/50 (D.M.).

Distribution: South of the South Island, Stewart Island, and the Snares, Auckland, Antipodes, Bounty and Chatham Islands, in moderately deep water.

Notosetia aoteana Powell. Pl. 13, fig. 2.

1937 *Notosetia aoteana* Powell, Disc. Rep. 15, p. 200, pl. 53, fig. 11.

This species is rather doubtfully congeneric with *Notosetia neozelanica*. It differs from the type in being smaller, with a narrow, deep umbilicus, and more spiral striations on the base. The protoconch appears to be finely punctate. Animal, operculum and radula unknown.

Holotype: Discovery II Stat. 933, off Three Kings Islands, 260 metres (Brit. Mus.).

Height 1.2 mm. Width 1 mm. (from Powell)

Material Examined: Paratypes (Powell Coll.); off North Cape, 15 fathoms (D.M.).

Family EATONIELLIDAE

The following species of *"Notosetia"* are eatoniellids and are discussed elsewhere (Ponder, 1965b).
"N." dilatata Powell, 1955; *"N." lampra* (Suter, 1908); *"N." pupinella* Finlay, 1927 and, *"N." verecunda* (Suter, 1908).

Family RISSOIDAE

Genus RISSOA Freminuille, 1813

Type (s.d., Bucquoy, Dautzenberg and Dollfus, 1884): *Rissoa ventricosa* Desmarest 1814.

Subgenus **HAURAKIA** Iredale, 1915

Type (o.d.): *Rissoa hamiltoni* Suter, 1898.

Both *Notosetia infecta* (Suter) and *N. aupouria* Powell should be included in *Haurakia,* as their shells agree closely with the other members of the subgenus in apertural features, texture, and coloration. The operculum and radula of *R.* (*H.*) *infecta* are very similar to those of *R.* (*H.*) *hamiltoni* and are figured in a forthcoming publication.

POWELLISETIA n. gen.

Type: *Rissoa porcellana* Suter, 1908

Shell small, whorls flattened, convex or shouldered, thin, either smooth, finely spirally striate or with one or two carinae, protoconch slightly tilted, rather flat on top, smooth or finely spirally striate. Peristome continuous, the columella nearly vertical, not much thickened; inner lip thin; outer lip sharp edged, somewhat thickened within, and, typically, a varix externally (not present in some species). A fairly strong to weak posterior sinus and a very shallow excavation anteriorly. Often perforate.

Animal: Unpigmented externally, with a long, narrow, bilobed snout. Cephalic tentacles long, slightly club-shaped, flattened, setose, with large eyes in swellings at their outer bases; foot long, wide in front, tapering regularly behind. No caudal tentacle. Mucous slit small and central.

Operculum: Thin, slightly concave, with a wide nucleus of approximately two revolutions. Columella edge convex, little or no thickening.

Radula: Central rather large, with a pair of lateral processes, a second pair internal to these. Cusps very small, numerous, median cusp small, forming the apex of a triangle, the small cusps on the sides. Lateral with a long outer portion, a smooth short area before the main cusp, finely denticulate behind. Marginals elongate, curved, finely serrate or smooth.

Powellisetia is clearly related to *Rissoa* (*Haurakia*) and the true rissoids. The only animal examined in any detail is *P. subtenuis* Powell, and, assuming this species is reasonably typical of the genus, the main differences seem to be in certain external features of the animal, such as the absence of a caudal tentacle, and details of the radula. (The animal, operculum and radula of *Haurakia hamiltoni* (Suter) are described in a forthcoming publication). The shell of *Powellisetia* is very similar to that of some species of *Haurakia,* differing mainly in general appearance due to the summation of a number of minor characters including colour, sculpture, and angulation of the body whorl. Both *Haurakia* and *Powellisetia* include species that will possibly need generic separation when more information is available.

Powellisetia is named for Dr. A. W. B. Powell, whose work has made the New Zealand rissoid fauna one of the best known in the world.

Powellisetia porcellana (Suter). Pl. 12, figs. 1, 2; Pl. 14, figs. 3-6.

1908 *Rissoa porcellana* Suter, Proc. Mal. Soc. Lond. 8, p. 30, pl. 2, fig. 29.
1908 *Rissoa stewartiana* Suter, Proc. Mal. Soc. Lond. 8, p. 31, pl. 3, fig. 30.
1909 *Rissoa* (*Setia*) *porcellana* Suter; Suter, Subantarctic Islands N.Z., 1, p. 18.
1913 *Rissoa* (*Setia*) *porcellana* Suter; Suter, Man. N.Z. Moll. p. 215, pl. 13, fig. 2.
1915 *Notosetia porcellana* (Suter); Iredale, Trans. N.Z. Inst. 47, p. 454.

1955 *Notosetia porcellana* (Suter); Powell, D.S.I.R., Cape Exped. Series, Bull. 15, p. 85.
1955 *Notosetia convexispira* Powell, D.S.I.R., Cape Exped. Series, Bull 15, p. 88, pl. 3, fig. 22.
1959 *Notosetia porcellana* (Suter); Boreham, N.Z. Geol. Surv. Pal. Bull. 30, p. 36 (Lectotype).
1959 *Notosetia stewartiana* (Suter); Boreham, N.Z. Geol. Surv. Pal. Bull. 30, p. 36 (Lectotype).
1962 *Notosetia porcellana* (Suter); Smith (in part), Rec. Dom. Mus. 4 (5), p. 57, figs. 21, 22.

The typical shell of *porcellana* is inflated, smooth, thin and transparent when fresh, with no sculpture except for weak, vertical, growth lines and often a few, subobsolete, spiral scratches. The protoconch is slightly tilted while the adult whorls are convex and often shouldered. Dead shells are white but fresh shells are transparent, the brownish visceral mass being visible through the shell. The peristome is rather thin, but there is usually a fairly strong varix just behind the outer lip, and a distinct posterior sinus is present. There is a fair amount of variation in the size, the outline of the whorls, and the height of the spire.

Smith (1962) synonymised *N. stewartiana* with *P. porcellana* on the basis of the similarity of the lectotypes which she figured. Examination of Suter's second cotype of *N. stewartiana* (see Boreham 1959) shows that it too is *N. porcellana,* thus leaving no doubt of the synonymy. The paralectotypes include two other species, *P. subtenuis* (Powell), and *P. tenuisculpta* (Powell). *Dardanula convexispira* (Powell) (fig. 6) is identical with *P. porcellana.* Paratypes of *convexispira* include several specimens of a new species and genus superficially similar to *Dardanula* but belonging to a new family (see Ponder, —c.)

Animal: (Stewart Island). Unpigmented externally, but other details not known. (Dried specimens).

Operculum: (Pl. 1, fig. 2). Thin, yellowish, horny, transparent, with a large nucleus. A concave area forms a weak ridge on underside which runs parallel to columella edge. Marginal area broad.

Radula: (Pl. 1, fig. 1). Central with two lateral processes and two short processes internal to these; main cusp small, about 8 fine denticles on either side of the cuspate part of tooth forming a triangle. Lateral with small cusp, no denticles internal to it, about 15 minute serrations externally, outer portion elongate not serrate. Marginal simple, no serrations visible, elongate.

Lectotype: Snares Island, 50 fathoms (G.S.).
Height 1.8 mm. Width 1.3 mm. (from Suter)

Material Examined:

Paratypes; 72 fathoms off Cape Saunders, Otago, Laws Coll. (A.M.); 60 fathoms, off Otago Heads, Finlay Coll. (A.M.); 50 fathoms, 10 miles E.N.E. off Otago Heads, Finlay Coll. (Powell Coll.); B.S. 190, 45° 45.4' S., 171° 5' E., East Otago Coast in Canyon B., 300 fathoms, M.V. "Alert", 16/8/55 (D.M.); Paterson Inlet, Stewart Island, 10 fathoms, on algae, -/4/50 (Smith Coll.); 3 fathoms off West end of Ulva Island, Paterson Inlet, 28/8/58 (Smith Coll.); off Port William, Stewart Island, 25 fathoms, -/6/59 (Smith Coll.); just off Weka Reef, Port Adventure, Stewart Island, -/2/63, A. Pollock (Smith Coll.); 50 fathoms, Snares Island, Finlay Coll. (A.M.); 50 fathoms, Snares Island (holotype and some paratypes of *Dardanula convexispira*) (A.M. and Powell Coll.); 100 fathoms off

Puysegur Point, South West Otago (Powell Coll.); B.S. 137, off Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin, 8/1/52 (D.M.); B.S. 107, Gaol Passage, Doubtful Sound, M.V. "Alert", W. H. Dawbin, 25 fathoms, 8/5/50 (D.M.); 25 fathoms, Doubtful Sound (Gardner Coll.); Bligh Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.).

Distribution: In moderately deep water off the South of the South Island, Stewart Island and the Snares Islands.

Powellisetia bilirata n. sp. Plate 14, fig. 17.

Shell minute, small for genus, rather solid, semi-transparent, strongly spirally striate, yellowish brown. Whorls 4, convex, angled by a strong spiral cord in middle of whorl; protoconch of $1\frac{1}{2}$ whorls, finely spirally striate, transparent, apex slightly inrolled. Body whorl rather large, periphery and base rounded. Aperture relatively small, solid, oval angled above; inner lip and columella moderately thickened, concave, columella separated from base below; outer lip weakly channelled above and below, sharp edged, a weak varix behind, and slightly thickened internally. Sculpture of fine, but distinct and regular, spiral threads, the suprasutural and middle cord strong, raised, rather sharp, the latter forming an angle on the whorls, the former being continued over periphery as a strong cord. About 6 fine spirals above, and 6 below middle cord on penultimate, about 16 on base, but these numbers vary slightly in paratypes. Strong cords constant, sometimes disappear over last part of body whorl, but usually continuous. Umbilical chink present but no true umbilicus. Colour pale yellowish-brown, protoconch reddish-brown. Animal, operculum and radula unknown.

Holotype: MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (ex Hipkins Coll.) (A.M.).

Height 1.05 mm. Width 0.675 mm.

Paratypes: Auckland Dominion and Canterbury Museums, Geological Survey, Lower Hutt, and K. Hipkins Coll.

Material Examined:

Holotype and paratypes; Spirits Bay, shell sand (Hipkins Coll.); 12 fathoms, Doubtless Bay, Finlay Coll. (A.M.); Taupo Bay, Whangaroa, 2/1/54 (Hipkins Coll.); MacGregor's Bay, shell sand (Hipkins Coll.); off Mayor Island, in fish stomach contents, G. Williams (Powell Coll.).

Powellisetia crassilabrum (Powell). Plate 14, figs. 20, 20a.

1940 *Notosetia crassilabrum*, Powell, Trans. Roy. Soc. N.Z. 70, p. 228, pl. 30, fig. 12.

This species is easily distinguished by the short spire, the much inflated body whorl, and the aperture which is very much thickened internally. The varix is wide and not very strong. The shell has no sculpture, is white and rather thin, and its protoconch is slightly tilted.

This species is closely related to *P. porcellanoides* (Powell) and to *P. unicarinata* (Powell). Animal, operculum and radula unknown.

Holotype: (Figs. 20, 20a). Tom Bowling Bay in shell sand (A.M.).

Height 1.1 mm. Width 0.9 mm.

Material Examined:

Holotype and paratypes; Spirits Bay, 1949 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/5/55 (Hipkins Coll.).

Distribution: Far North of the North Island.

Powellisetia gradata (Suter). Plate 13, figs. 9-13.

1908 *Anabathron gradatum* Suter, Proc. Mal. Soc. Lond. Vol., 8, p. 32, pl. 3, fig. 33.
1913 *Anabathron gradatum* Suter; Suter, Man. N.Z. Moll. p. 218, pl. 13, fig. 7.
1915 *Notosetia? gradatum* (Suter); Iredale, Trans. N.Z. Inst., 47, p. 454.
1933 *Notosetia gradata* (Suter); Powell, Rec. Cant. Mus. 4, p. 36, text fig. 2, (Lectotype).
1933 *Notosetia fairchildi* Powell, Rec. Cant. Mus. 4, p. 36, text fig. 3.
1955 *Notosetia gradata* (Suter); Powell, D.S.I.R., Cape Exped. Series Bull., 15, p. 55.
1962 *Notosetia gradata* (Suter); Smith Rec. Dom. Mus. 4 (5), p. 53.

This species has a rather thick shell, typically with quadrate outlines to the whorls. It is white, with fine but distinct spiral striae over the whole surface. The strength of these striae varies considerably in different specimens, but they are usually stronger on the shoulder and the base. The axial growth lines are also rather distinct. There is a weak varix and the aperture is considerably thickened internally. A shallow umbilical chink is present. Even in one population there is considerable variation in the shell size, the strength of the shoulder and the height of the spire (c.f. figs. 9-13). Bounty Island specimens usually have rounded shoulders (Powell's *N. fairchildi* (figs. 10, 10a)), but agree with *P. gradata* in all other details, suggesting a possible subspecific race if it were not that occasional typical *P. gradata* are found at the Bounty Islands. An intermediate series of shells from 72 fathoms off Cape Saunders, suggests that the Bounty Island form is only a regional variation. Animal, operculum and radula unknown.

Lectotype: 50 fathoms off the Snares Islands (Geol. Surv.).
Height 2.1 mm. Width 1.3 mm. (from Powell)

Material Examined:

Paralectotypes; 72 fathoms, off Cape Saunders, Laws Coll. (A.M.); 30 fathoms, off Halfmoon Bay, Stewart Island, -/10/51 (Smith Coll.; 50 fathoms, off the Snares Islands, Finlay Coll. (A.M.) and H. Suter (D.M.) (syntypes); Bounty Islands, 170 fathoms, Capt. Fairchild (A.M.) (Holotype of *N. fairchildi*); off Bounty Islands (Powell Coll.); 170 fathoms, Bounty Islands (Powell Coll.).

Distribution: The South-East of the South Island, Stewart Island, the Snares and Bounty Islands in deep water.

Powellisetia lineata (Smith). Plate 14, figs. 16, 16a.

1962 *Notosetia lineata* Smith, Rec. Dom. Mus. 4 (5), p. 55, fig. 13.

The shell has a rather short spire, convex whorls, and is yellowish, with 3 chestnut bands on the spire whorls and 1-2 on the base. Very indistinct spiral striae are present on the shell surface. The aperture has a very weak posterior sinus, no varix and is only slightly thickened internally.

Animal: (paratype): Unpigmented externally, with moderately long, slightly flattened, and not noticeably club-like, tentacles; snout rather wide, bilobed; eyes fairly large. Penis long and narrow, muscular, straight; terminal portion flattened, club-like and glandular, this having a long finger-like process on one side and a much shorter projection on the other (dried material). Radula unknown.

Operculum: Typical. Central part of the large nucleus slightly thickened.

Holotype: Halfmoon Bay, Stewart Island, low tide, on algae (D.M.).
Height 1.41 mm. Width 0.96 mm. (from Smith)

Material Examined:

Paratypes; Bathing Beach, Stewart Island, O. Allan (D.M.); Aker's Point, Halfmoon Bay, Stewart Island, M. Spong, 22/2/63 (W.F.P.).

Distribution: Stewart Island, living in algae at low tide.

Powellisetia microstriata (Murdoch). Plate 14, figs. 1, 2.

1905 *Rissoa microstriata* Murdoch, Trans. N.Z. Inst., 37, p. 229, pl. 7, fig. 25.
1913 *Rissoa (Setia) microstriata* Murdoch; Suter, Man. N.Z. Moll., p. 214, pl. 12, fig. 25.
1915 *Notosetia microstriata* (Murdoch); Iredale, Trans. N.Z. Inst. Vol., 47, p. 454,
1955 *Notosetia antipoda* Powell, D.S.I.R. Cape Exped. Series Bull. 15, p. 86, pl. 3, fig. 19.
1962 *Notosetia microstriata* (Murdoch); Smith, Rec. Dom. Mus. 4 (5), p. 56, figs. 14, 15.

This species has a rather tall-spired shell, with 4½-5 moderately convex whorls. The very fine spiral sculpture appears to be in the shell substance rather than as ornament on the surface, and is therefore only visible in semi-transparent shells. There is a very weak apertural varix in most specimens, a little internal thickening, a broad posterior sinus, and no umbilicus. The protoconch looks smooth, but very fine spirals are visible under high power. There is some variation, chiefly in size.

Smith (1962) finally settled the correct location of this species by showing that the type, supposed to have come from Whangaroa Harbour, probably came from Foveaux Strait. I have checked the type against Smith's specimens and agree entirely with her conclusion.

The holotype of *Notosetia antipoda* Powell, (fig. 2) is a dead opaque shell with the spiral sculpture invisible on the body whorl, but visible on the spire whorls. It is identical with Foveaux Strait specimens of *P. microstriata.*

Animal: (Stewart Island). Unpigmented externally, tentacles moderately long, eyes large, but no other details known. (Dried material). Radula unknown.

Operculum: Thin, transparent, colourless, slightly concave, no sign of spiral sculpture. Nucleus a little smaller than in other members of genus, of two revolutions. Marginal area moderately wide, columella edge rather convex, right end rounded, growth lines strong.

Holotype: Foveaux Strait ("Whangaroa Harbour") (D.M.).
Height 2.07 mm. Width 1.11 mm. (from Smith)

Material Examined:

Holotype; 50 fathoms, 6 miles E.N.E. of Otago Heads, Finlay Coll. (A.M.); 75 fathoms, Cape Saunders, Otago, Laws Coll. (A.M.); Bluff, Finlay Coll. (A.M.); Foveaux Strait, oyster beds near Fairchild River, 28/9/55 (Smith Coll.); off Stewart Island, -/3/51 (Gardner Coll.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.); Port Adventure, Stewart Island, 30 fathoms, -/5/47 (Smith Coll. and Powell Coll.); off Halfmoon Bay, Stewart Island, 30 fathoms (Smith Coll.); 30 fathoms, off South Cape, Stewart Island, E. Smith (Powell Coll.); off Big South Cape Islands, Stewart Island, 40 fathoms, 10/4/54 (Smith Coll.); B.S. 106, between Unnamed Island and Breaksea Sound, 20 fathoms, M.V. "Alert", W. H. Dawbin, 7/5/50 (D.M.); 50 fathoms, Snares Islands, (holotype and paratypes of *N. antipoda*); Bounty Islands, 170 fathoms (Powell Coll.) (among paratypes of *N. fairchildi*).

Distribution: Moderately deep water off the South of the South Island, Stewart Island and the Snares and Bounty Islands.

Powellisetia porcellanoides (Powell). Pl. 12, fig. 6; Pl. 14, figs. 22, a, b.

1937 *Notosetia porcellanoides* Powell, Disc. Rep. 15, p. 200, pl. 53, fig. 9.

The shell is rather small, with a fairly tall spire, and lightly convex whorls. It has a few spiral scratches on the surface when fresh, but these are easily worn off like those on the one available paratype. The protoconch is large, smooth, and strongly tilted. A moderate varix and a very weak posterior sinus are present. There is some variation in the size and in the convexity of the whorls.

Animal: (Off Mayor Island). Yellowish externally with a bilobed, moderately long snout which is apparently slightly expanded in front. Tentacles fairly long, eyes large on swellings at outer bases. (Dried specimens).

Operculum: (Pl. 1, fig. 3). Thin, colourless, transparent, slightly concave, with a wide nucleus of about two spirals. There is faint spiral sculpture visible and a single, faint, wide spiral line over the last $1\frac{1}{2}$ revolutions; growth lines strong. Marginal area fairly wide, thin. Columella edge slightly convex, right end rather pointed.

Radula: Central tooth with a small cusp and traces of minute serrations on either side. Lateral with one main cusp and a smaller one internal to it, no others visible, typical shape for genus. Marginals typical in shape and no serrations visible. The extremely small size of the teeth make it difficult to be sure whether or not fine serrations do occur.

Holotype: Off Three Kings Islands Discovery II Stat. 933, 260 metres. (Brit. Mus.).

Height 1.35 mm. Width 0.88 mm. (from Powell)

Material Examined:

Paratype (Powell Coll.); 50 fathoms, between Cape Maria Island and Three Kings Islands, 1961 (Hipkins Coll.); Spirits Bay, shell sand (Hipkins Coll.); Taupo Bay, Whangaroa, 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); Tryphena Bay, Great Barrier Island, -/1/52 (Hipkins Coll.); 35 fathoms, Tuhua Reef, Mayor Island, G. Williams (Powell Coll.).

Distribution: In moderately deep to shallow water off the far North and North East of the North Island.

Powellisetia c.f. porcellanoides (Powell). Plate 14, fig. 21, 21a.

A few specimens examined have moderately strong spiral striations over the entire shell. There are also small differences in the shell shape and the convexity of the whorls.

Material Examined:

12 fathoms, Awanui Bay, Finlay Coll. (A.M.); Mt. Maunganui-Mayor Island area in fish stomach contents, G. Williams (Powell Coll.).

Powellisetia retusa (Powell). Plate 2, figs. 7, 8.

1927 *Notosetia retusa* Powell, Rec. Cant. Mus., Vol. 3 (2), p. 17, pl. 21, fig. 3.
1962 *Notosetia retusa* Powell; Smith, Rec. Dom. Mus., 4 (5), p. 59.

This shell is distinctive, with its shining surface, tall spire, rather pupoid form, rounded whorls, and rather distinct posterior sinus. There is no umbilicus, and indistinct irregular spiral striae are developed over the surface. There is a weak varix and the aperture is thickened within. The holotype is a squatter shell than normal, and a taller paratype is figured for comparison (fig. 8). Though related to *P. gradata* (Suter), this species shows also affinities with *P. microstriata* (Murdoch).

Animal: (Snares Islands, 50 fathoms). Unpigmented externally, with long cephalic tentacles. (Dried specimens). Radula unknown.

Operculum: Thin, slightly concave, colourless, nucleus rather wide, about two revolutions, growth lines weak, marginal area wide, right end bluntly angled, columella edge rounded. One or two weak spiral lines emerge from the nucleus.

Holotype: (Figs. 7, 7a). 170 fathoms, off Puysegur Point, -/12/08 (Cant. Mus.).

Height 1.825 mm. Width 1.05 mm.

Material Examined:

Holotype and paratypes; 60 fathoms, off Otago Heads, Finlay Coll. (A.M.); 72 fathoms, off Cape Saunders, Laws Coll. (A.M.); Middle Grounds, Foveaux Strait, 15-30 fathoms, -/6/51 (D.M.); South Cape, Stewart Island, -/1/55 (Gardner Coll.); 85 fathoms, Enderby Island, Finlay Coll. (A.M.); 100 fathoms, off Puysegur Point (D.M.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", W. H. Dawbin, 6/5/50 (D.M.); 50 fathoms, off Snares Islands, Finlay Coll. (A.M.) and H. Suter (D.M.); 95 fathoms, Auckland Islands, Finlay Coll. (A.M. and Powell Coll.); 50 fathoms, off Bounty Islands, Finlay Coll. (A.M.), 170 fathoms (Powell Coll.), 40-50 fathoms (D.M.) and 40 fathoms, J. A. Bollons (D.M.); Bounty Islands (D.M.); Chatham Island Exped. Stat. 34, 44° 04' S., 175° 23.5' E., East of Forty-fours, 130 fathoms, 1/2/54, M.V. "Alert" (D.M.).

Distribution: The South of the South Island, Stewart Island, Snares, Auckland, Bounty and Chatham Islands, in fairly deep water.

Powellisetia subgradata (Powell). Plate 13, fig. 14.

1937 *Notosetia subgradata* Powell, Disc. Rep. 15, p. 200, pl. 53, fig. 10.

The shell is small, and the whorls have a strongly angled shoulder which is often carinate. On the shoulder very fine, close spirals are present in the paratypes, though these are not mentioned in Powell's description of the holotype. The spire is short and the protoconch large, dome-shaped, slightly tilted and apparently smooth. There is a very weak basal canal and a rather weak posterior canal between the shoulder and the suture. The aperture is thickened internally but there is no varix. The shoulder and carina vary somewhat in strength, most specimens other than the paratypes having no carina, and some having the shoulder bluntly rounded.

Animal: (Off Mayor Island). Unpigmented, other details not known (dried material).

Operculum: Typical of the genus. Oval, with a wide nucleus, broad marginal area, and slightly convex columella edge.

Radula: Typical of the genus, the fine serrations being almost invisible because of its small size.

Holotype: Disc. Stat. 933, off Three Kings Islands, 260 metres (Brit. Mus.).

Height 1.7 mm. Width 1.1 mm. (from Powell)

Material Examined:

Paratypes (Powell Coll.); Spirits Bay, shell sand (Hipkins Coll.); Tom Bowling Bay, -/1/52 (Gardner Coll.); 4½ fathoms off Reach Island, Whangaroa, 5/1/56 (W.F.P.); Taupo Bay, Whangaroa, 2/1/54 (Hipkins Coll.); Tapeka Point, Russell (Hipkins Coll.); Tryphena, Great Barrier Island, 5-6 fathoms (Powell Coll.); Tryphena, Great Barrier Island (Hipkins Coll.); 35 fathoms, Tuhua Reef, Mayor Island, in fish stomach contents, G. Williams (Powell Coll.).

Distribution: The far North and North East of the North Island in shallow to moderately deep water.

Powellisetia subtenuis (Powell). Pl. 12, figs. 4, 5, 9; Pl. 14, figs. 7-15.

1937 *Notosetia subtenuis* Powell, Disc. Rep. 15, p. 200, pl. 53, fig. 8.
1940 *Notosetia multilirata* Powell, Trans. Roy. Soc. N.Z., 70, p. 228, pl. 31, fig. 10.
1940 *Notosetia subcarinata* Powell, Trans. Roy. Soc. N.Z., 70, p. 228, pl. 30, fig. 11.
1962 *Notosetia foveauxana* Smith, Rec. Dom. Mus., 4 (5), p. 53, fig. 9.
1962 *Notosetia porcellana* (Suter); Smith (in part), Rec. Dom. Mus., 4 (5), pp. 57-59, fig. 20.
1962 *Notosetia tenuisculpta* Powell; Smith (not of Powell); Rec. Dom. Mus., 4 (5), p. 59, fig. 23.

This "species" is represented throughout New Zealand by what appears to be a series of complexly variable populations. Several names have been given to shells which, when series from other localities are examined, appear to intergrade with other forms. Smith lumped the most common Stewart Island form (figs. 8, 8a) with *P. porcellana,* but *P. subtenuis* is always separable by its lightly convex whorls, fine spiral lirae, and smaller size.

The shell is umbilicate and usually white, but can be coloured uniform brown or brown with a peripheral white band (fig. 10) (= *tenuisculpta* of Smith). The aperture has a varix and a moderate posterior canal. The protoconch is often finely spirally striate. The height of the spire is rather variable, shortening of this being coupled with inflation of the body whorl, which occurs in populations in the far North, and has been given a separate name (*multilirata* Powell) (fig. 13). *P. foveauxana* Smith, (fig. 11) is the southern equivalent but other forms occur also (fig. 12).

Shells from the far North show much variation. Series from Doubtless Bay and 100 fathoms off Big King Island, Three Kings Group, (A.M. Coll.), show intergrading shells between typical *subtenuis,* shells very close to Stewart Island *subtenuis* (pl. 3, fig. 9), *multilirata* and *subcarinata* Powell (figs. 15, 15a) and in view of this intergradation, these are all considered as belonging to the one species. The synonymy of *N. subcarinata* is perplexing but is based on a series of strongly-angled and even carinate shells having fine spiral sculpture as in *multilirata* (fig. 14) merging into keeled shells identical with typical *subcarinata* (i.e. with no spiral sculpture). On the available evidence I consider the above course of action best but it is quite possible that better series of shells, coupled with information obtained from examination of the animal, will re-establish some of the above names and, perhaps, further species.

A form, with strong granulated spirals on an oblique protoconch, is found at the Bounty Islands, but insufficient material is available to determine its status with certainty. A single shell from the Bounty Islands was, however, typical *subtenuis*.

Animal: (Portobello) (Pl. 1, fig. 9). Externally white, the dark viscera showing through the semi-transparent shell. Snout narrow, bilobed, not expanded, with a slight yellowish tinge; buccal mass bright yellow. Cephalic tentacles long, with slightly swollen outer ends, covered with stationary, short cilia. Eyes large, with a yellow glandular area above and behind. Foot wide in front, slightly dented in the anterior margin, tapering gradually behind to a sharp posterior end. Dorsal and ventral surfaces with posteriorly directed cilia, these cilia longer and more active in a strip under the anterior margin. Propodium small and rather far back from the anterior edge. Anterior mucous gland large, posterior gland with a short central slit. No metapodial tentacle. Opercular muscle bright yellow. Osphradium large, light brown. Stomach (a specimen from off Mayor Island) containing fairly large foraminifera, and a crystalline style present.

Operculum: (Fig. 5) (Stewart Island, Mayor Island). Colourless, very thin, very lightly concave with a wide nucleus, this region being the centre of concavity, and is of about two revolutions. Faint, fine, spiral lines visible but growth lines fairly prominent. A rather broad marginal area on outer side. Columella edge rather convex, right end slightly pointed.

Radula: (Fig. 4). Rather short and broad. Central moderately large, cutting edge triangular, 8-1-8, cusps small, denticulate. Lateral with 1 large cusp, finely serrate on outer side. Inner marginal curved, finely serrate; outer marginal appears to be smooth, otherwise similar to inner.

Holotype: Discovery II Stat. 933, off Three Kings Islands, 260 metres (Brit. Mus.).

Height 1.2 mm. Width 0.8 mm. (from Powell)

Material Examined:

Paratypes (Powell Coll.); 100 fathoms, off Great Island, Three Kings Islands, Finlay Coll. (including holotypes and paratypes of *N. multilirata* and *N. subcarinata*) (A.M.); 50 fathoms, between Cape Maria Island and Three Kings 1961 (Hipkins Coll.); off North Cape, 75 fathoms (D.M.); Spirits Bay, shell sand (Hipkins Coll.); 12 fathoms, Awanui Bay, Finlay Coll. (A.M.) and 10 fathoms, Finlay Coll. (A.M.); 10-12 fathoms, off Manganui, W. LaRoche 1928 (Powell Coll.); 60 fathoms, off the Poor Knights Islands, Finlay Coll. (A.M.); 12 fathoms, Doubtless Bay, Finlay Coll. (A.M.); 38 fathoms, Cuvier Island, Finlay Coll. (A.M.); 25 fathoms, off Hen and Chickens, Finlay Coll. (A.M.); 42 fathoms, 1 mile South of Chicken Island, Hen and Chickens Islands, 5/12/16 (Powell Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); off High Island, Taurikura Bay, Whangarei Heads, 1-5 fathoms, 18/5/61 (W.F.P.); Tryphena Bay, Great Barrier Island, 5-6 fathoms (Powell Coll.); Dredge 5, Manukau Harbour, 4½ fathoms, between Cornwallis and Big Muddy Creek (Powell Coll.); 3 miles N.E. of Channel Island, Hauraki Gulf, 26 fathoms, 1/12/16 Capt. Bollons (D.M.); 20 fathoms, 5 miles North of Mount Maunganui, fish stomach contents, G. Williams (Powell Coll.); 90 fathoms, ½ mile off N.E. end of Mayor Island, fish stomach contents, G. Williams (Powell Coll.); Island Bay, Wellington, shell sand, 2/10/56 (W.F.P.); B.S. 190, 45° 45.4' S., 171° 5' E., off East Otago Coast, Canyon B., 300 fathoms, M.V. "Alert", 16/8/55 (D.M.); 50 fathoms off Oamaru, Finlay Coll. (A.M.); Taieri Beach, Otago, algae, Finlay Coll. (A.M.); 60 fathoms, off Otago Heads, Finlay Coll. (A.M.); 50 fathoms,

10 miles E.N.E. of Otago Heads, Finlay Coll. (Powell Coll.); 72 fathoms, off Cape Saunders, Otago, Laws Coll. (A.M.); Bluff, Finlay Coll. (A.M.); Stewart Island, 18 fathoms, H. Suter (D.M.); off Solander's Island, algae, -/11/56 (Smith Coll.); East of Ruggedy, Stewart Island, 25 fathoms, 4/11/56 (Smith Coll.); off Port William, 25 fathoms, -/6/59 (Smith Coll.); Chew Tobacco Grounds, near East Cape, Stewart Island, O. Allan, -/3/51 (D.M.); 18 fathoms, Port Pegasus, Stewart Island (among paralectotypes of *N. stewartiana*) (Geol. Surv. D.M. and Powell Coll.); Port Adventure, Stewart Island, in bryozoan, 18/6/58 (Smith Coll.), (= *tenuisculpta* of Smith); Ocean Beach, Stewart Island, low tide, algae, 28/12/52 (Smith Coll.) (= *tenuisculpta* of Smith); off Poutama Island, South Cape, Stewart Island, 30 fathoms (paratypes of *N. foveauxana* and also *tenuisculpta* of Smith) (Smith Coll. and D.M.); 100 fathoms, off Puysegur Point, South West Otago (D.M.); B.S. 107, Goal Passage, Doubtful Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 8/5/50 (D.M.); Doubtful Sound, 50 fathoms (W.F.P.); B.S. 185, Casewell Sound, 10 fathoms, R. K. Dell, 23/3/49 (D.M.); 50 fathoms, off Snares Islands (A.M. and Powell Coll.); Campbell Island, Cape Exped., R. Sorensen, 1943 (A.M.); (c.f.) Bounty Islands (Powell Coll.); (c.f.) Bounty Islands, 40 fathoms, J. A. Bollons (D.M.); Bounty Islands (Powell Coll.); 95 fathoms, Auckland Island, Finlay Coll. (A.M.); Mernoo Bank, 43° 21' S., 124° E., 52 fathoms (D.M.); Chatham Islands Exped. Stat. 34, 44° 04' S., 175° 23.5' E., East of the Forty-fours, 130 fathoms, M.V. "Alert" (D.M.); Discovery Bank, 140 metres, R.R.S. Discovery II Stat. 2772, 1/12/50 (D.M.).

Distribution: Throughout New Zealand, Stewart Island, and the Snares, Bounty, Campbell, Auckland and Chatham Islands, in shallow to deep water.

Powellisetia tenuisculpta (Powell). Pl. 12, fig. 3; Pl. 14, figs. 18, 19.

1933 *Notosetia tenuisculpta* Powell, Rec. Cant. Mus. 4, p. 37, pl. 6, fig. 7.
1955 *Notosetia tenuisculpta* Powell; Powell, D.S.I.R., Cape Exped. Series, Bull., 15, p. 86.
1962 *Notosetia porcellana* (Suter); Smith (in part) (not of Suter), Rec. Dom. Mus. 4 (5), p. 57.

The shell of this species is easily distinguished by its brown protoconch, which is a feature not seen in any other southern New Zealand species of this genus. The adult whorls are yellowish to white. The spire is moderately tall, the whorls convex, and the whole shell usually sculptured with fine close spirals, although these may sometimes be fairly strongly developed and crossed by weak, but distinct, axial growth lines. The aperture has no varix or internal thickening, but a very weak posterior canal is present. The umbilicus is variably developed, and occasionally absent. Fresh shells are semi-transparent, with the spiral sculpture clearly visible. Dead specimens become opaque and the sculpture is easily worn off. There is variation in the shell size, the relative width, and the size of the umbilicus.

Specimens of *tenuisculpta* from Stewart Island were included in the range of variation of *P. porcellana* by Smith (1962) along with *P. subtenuis,* while she recognised a form of *subtenuis* as *tenuisculpta.* Stewart Island shells of *tenuisculpta* (fig. 19) are often a little larger than the type series, but agree well in other particulars. This species is easily distinguished from *subtenuis,* to which it is closely related, by the points mentioned above, and by the relatively taller spire and the rather more convex whorls.

Animal: (Pegasus, Stewart Island). Not pigmented externally but other details not known. (Dried material).

Operculum: (Stewart Island). Typical; thin, yellowish, transparent, slightly concave, nucleus large, slightly thickened in centre.

Radula: (Fig. 3). Similar to *P. subtenuis,* but with fewer denticles (about 6) beside main cusp on central tooth. Marginals appear to be smooth, though they may be very finely serrate.

Holotype: (Figs. 18, 18a). 170 fathoms, off Bounty Islands, 1/6/53 (Cant. Mus.).

Height 1.25 mm. Width 0.75 mm.

Material Examined:

Holotype and paratypes; off Port William, Stewart Island, 25 fathoms, -/6/59 (Smith Coll.); Port Pegasus, Stewart Island, 28/7/59 (Smith Coll.); East of Ruggedy, Stewart Island, 25 fathoms, 4/11/56 (Smith Coll.); off Pontama, South Cape, Stewart Island, 30 fathoms (Smith Coll.); off Puysegur Point, South West Otago, 100 fathoms (D.M.); Doubtful Sound, 50 fathoms (W.F.P.); Bounty Islands (Powell Coll. and D.M.) and 50 fathoms, Finlay Coll. (A.M.).

Distribution: The extreme South of the South Island, Stewart Island and the Bounty Islands, in moderately deep water.

Powellisetia unicarinata (Powell). Plate 14, fig. 23, 23a.

1930 *Notosetia unicarinata* Powell, Trans. N.Z. Inst., 61, p. 543, pl. 88, fig. 18.

This small species is closely allied to *P. porcellanoides* (Powell), but differs from that species in its strongly angled, carinate shoulder on all adult whorls. Like *P. porcellanoides,* the shell has a fairly tall spire and strongly tilted protoconch. The type is worn, fresh specimens having traces of spiral scratches on the adult whorls, and a few very faint spirals on the protoconch. Sometimes a weak spiral cord, emerging from the suture, is developed on the base. The umbilicus is usually open. The aperture has a very weak posterior sinus and a weak external varix. The chief variation is in the relative width of the spire.

Animal: (Mayor Island). Unpigmented externally but other details unknown. (Dried material).

Operculum: Colourless, nucleus very slightly thickened and rather wide. Growth lines fairly strong, marginal area fairly narrow.

Radula: Similar to that of P. *porcellanoides.*

Holotype: (Figs. 23, 23a). Tryphena Bay, 5-6 fathoms, Great Barrier Island(Powell Coll.).

Height 1.1 mm. Width 0.7 mm.

Material Examined:

Holotype and paratypes; 5 fathoms, between Cape Maria Island and mainland, -/6/62 (Hipkins Coll. and Gardner Coll.); Spirits Bay, 1949 (Hipkins Coll.); 22 fathoms, ½ mile South of Stephenson's Island, off Whangaroa (Hipkins Coll.); Taupo Bay, Whangaroa, 2/1/54 (Hipkins Coll.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); 35 fathoms, Tuhua Reef, Mayor Island, in fish stomach contents, G. Williams (Powell Coll.).

Distribution: The far North and North East of the North Island, in shallow to moderately deep water.

RISSOPSIS Garrett, 1873

Type (monotypy): *R. typica* Garrett, 1873

Cotton (1944) used the New Zealand genus *Eusetia* Powell to cover the Australian species previously referred to as *Rissopsis,* but

later authors reverted to the earlier generic name. *Eusetia expansa* (Powell), the type of *Eusetia*, is a pyramidellid and therefore this genus is not applicable in the Rissoidae.

Cotton describes *Rissopsis typica* Garrett as "a most peculiar species from Viti and Samoa Islands, which is a long exsert shell with constricted and abnormally narrow whorls with a tendency to oblique, twisted plications more or less obsolete." He goes on "the resemblance to Australian and New Zealand species is in no way apparent, the apertures here being larger, more expanded and more reflected peristome, though discontinuous."

I agree with Cotton's conclusions and provide the name *Austrorissopsis* n. gen. for the Australian species previously called *Rissopsis*, and nominate *Rissopsis brevis* May, 1919, as type. I have tentatively placed Monterosato's genus, *Peringiella*, as a subgenus of *Rissopsis*.

Subgenus **PERINGIELLA** Monterosato, 1878

Type (monotypy): *Rissoa laevis* Monterosato, 1877

The group of Southern European genera including *Peringiella* and *Pisinna* Monterosato are poorly known. Tryon (1887, p. 341) discussed the type of *Peringiella* as follows:— "The only description of this species is its solidity and the teeth of the aperture readily distinguished it from its congeners. The figure does not exhibit any apertural teeth". Cossmann (1921) gives *P. nitida* Brusina from the Mediterranean, as the type of *Peringiella*. This species only superficially resembles *P. laevis*, having a rather different aperture with no apertural teeth. *P. nitida* closely resembles a new species from New Zealand, described below. *Peringiella* is used here provisionally to cover certain New Zealand species, though examination of the type will probably indicate a new texon is required.

Coan (1964) has reduced *Peringiella* to a subgenus of *Cingula*. The shells of the smooth "cingulids" differ markedly from those of true *Cingula*, and deserve generic separation.

"Notosetia" lubrica (Suter) and *"N." simplex* Powell, are also placed tentatively in *Peringiella*, though not agreeing so well with *P. nitida*.

The one species, for which the details of the radula and operculum are known, shows that this group is related to *Powellisetia*, but differs in certain details. These are:—

Operculum: Marginal area wide, ragged, nucleus rather small.

Radula: Central with basal processes extended laterally. Lateral with a very long outer portion. Both central and lateral have relatively fewer cusps than species of *Powellisetia*, central 3 + 1 + 3, lateral 0 + 1 + 8.

The shell is distinctively tall, smooth, with a large, smooth, dome-shaped protoconch. The description of the new species can be taken as typical of the group.

Rissopsis (Peringiella) elegans n. sp. **Pl. 12, figs. 7, 8; Pl. 13, figs. 3, 3a.**

Shell ovate—conic, white, shining, semi-transparent, false margined, with no sculpture. Spire tall, outline faintly convex, whorls 5, slightly

convex, suture false margined below. Protoconch large, $1\frac{1}{2}$ whorls, dome-shaped, smooth. Aperture large, pyriform, angled posteriorly where there is a fairly distinct posterior sinus, rounded below. Columella concave, inner lip thin. Peristome continuous, not much thickened. A weak external varix close behind the sharp outer lip which is thickened a little internally. No umbilicus, but columella departs from body wall slightly.

Animal: (Paratype). Yellowish-white externally, with broad, flat, short cephalic tentacles, which have minute eyes at their outer bases. The eyes have a white glandular area surrounding them. Snout broad, bilobed. (Dried material).

Operculum: (Fig. 8). Thin, yellowish, transparent with a small indistinct nucleus, the central part of which is irregularly thickened to a small extent. Columella edge lightly convex, growth lines moderately strong. Marginal area thin, brown, distinct, the edges tatered.

Radula: (Fig. 7). Central rather small, cusps 3 + 1 + 3, small, two latero-basal processes and a pair of basal knobs. Lateral elongate, 0 + 1 + 8, cusps small. Marginals elongate, curved, inner finely serrate, outer narrower, appears to be smooth.

Holotype: (Fig. 3, 3a). 22 fathoms, $\frac{1}{2}$ mile West side of Stephenson's Island, $3\frac{1}{2}$ miles from Whangaroa, K. Hipkins, 29/12/53 (ex Hipkins Coll.) (A.M.).

Height 3.1 mm. Width 2.15 mm.

Paratypes: (2) Dominion Museum, K. Hipkins Coll.

Material Examined: Holotype and paratypes.

Rissopsis (Peringiella) lubrica (Suter). **Plate 13, figs. 4-6.**

1898 *Rissoa lubrica* Suter; Proc. Mal. Soc. Lond., 3, p. 5, fig. 3.
1908 *Rissoa* (*Setia*) *lubrica* Suter; Suter, Proc. Mal. Soc. Lond., 8, p. 29, pl. 2, fig. 24.
1913 *Rissoa* (*Setia*) *lubrica* Suter; Suter, Man. N.Z. Moll., p. 213, pl. 12, fig. 23.
1924 *Notosetia pupa* Finlay, Trans. N.Z. Inst. 55, p. 488.
1927 *Notosetia benthicola* Powell, Rec. Cant. Mus. 3, p. 117, pl. 21, fig. 1.
1933 *Notosetia lubrica* (Suter); Powell, Rec. Auck. Inst. Mus., 1, p. 198, pl. 34, fig. 3.
1962 *Notosetia lubrica* (Suter); Smith, Rec. Dom. Mus. 4 (5), p. 55, figs. 16, 17, 17a.

This distinctive species has a tall spire, rather convex, sculptureless whorls which are strongly margined below the suture, a more-or-less D-shaped aperture which is strongly thickened within, and a very weak varix externally. Posteriorly there is a broad, fairly deep sinus in the outer lip and anteriorly a shallow concavity, so that the middle part of the outer lip appears to swing forward. The number of whorls varies from about $3\frac{1}{2}$ to 5, and thus the adult size and relative height of the spire are rather variable (c.f. figs. 4, 5).

Smith (1962) figures the holotype of *P. lubrica* which is a rather small shell for the species, and the holotype of *P. benthicola* Powell, which she considers to be a synonym of *P. lubrica*—a conclusion with which I definitely agree. Smith also shows how *R.* (*P.*) *lubrica* possibly intergrades with *R.* (*P.*) *simplex*, but I have not seen her specimens to confirm this.

R. (*P.*) *lubrica* is placed in *Peringiella* tentatively on account of its basic similarity to *R.* (*P.*) *elegans* n. sp.

Animal, operculum and radula unknown.

Holotype: Foveaux Strait, 15 fathoms (Cant. Mus.).

Height 1.75 mm. Width 0.85 mm. (from Smith)

Material Examined:

72 fathoms, Cape Saunders, Otago, Laws Coll. (A.M.); 100 fathoms, off Puysegur Point (paratypes of *benthicola*) (Cant. Mus.) and (D.M. and Gardner Coll.); Middle Grounds, Foveaux Strait, 30 fathoms, O. Allan, -/6/51 (D.M.); Fish Rock, Foveaux Strait, 30 fathoms, O. Allan, -/6/51 (D.M.); Bathing Beach, Stewart Island (D.M.); 50 fathoms, Doubtful Sound (W.F.P.).

Distribution: The South of the South Island, and Stewart Island, in deep water.

Rissopsis (Peringiella) simplex (Powell).

1927 *Lironoba simplex* Powell, Rec. Cant. Mus., 3 (2), p. 116, pl. 21, fig. 4.
1930 *Notosetia simplex* Powell, Trans. N.Z. Inst., 61, p. 544.
1962 *Notosetia simplex* Smith, Rec. Dom. Mus. 4 (5), p. 59, figs. 18, 19.

The shell is distinctive, with its strongly angulate whorls, tall spire and smooth shell. Smith (1962) has suggested that this species intergrades with *R.* (*P.*) *lubrica* (p. 55-56 and 59). I have not seen her specimens, nor the holotype of *simplex*, but only the juvenile paratype. Smith's conclusions thus must stand for the moment, but it is clear that R. (*P.*) *simplex* is very closely allied to *R.* (*P.*) *lubrica*. Animal, operculum and radula unknown.

Holotype: Off Puysegur Point, South-West Otago, 170 fathoms (Cant. Mus.).

Height 2.0 mm. Width 0.9 mm. (from Powell)

Material Examined: Paratype.

Distribution: Far South of the South Island, and Stewart Island (Smith), in deep water.

Family CINGULOPSIDAE Fretter and Patil, 1958

(Type genus *Cingulopsis* Fretter and Patil, 1958.) (*Cingula fulgida* J. Adams, 1797) = *Helix fulgidus* J. Adams, 1797).

The anatomy of *Eatonina micans* (Webster) will be described elsewhere (Ponder,—a.) and this is shown to closely resemble the European *Cingulopsis fulgida* (Fretter, 1953, and Fretter and Patil, 1958). There are, however, at least three important differences which separate the two species. The pallial oviduct of *C. fulgida* has a ciliated duct opening into the mantle cavity, whereas this is absent in *E. micans*. A short, broad metapodial tentacle, present in *C. fulgida*, is absent in *E. micans*, and the operculum of the former species is thin and simple while that of the latter is thick and bears a peg. Possibly the characteristics of *Cingulopsis fulgida* are typical of an, as yet unidentified, Northern Hemisphere group of species, in the same way that those of *E. micans* appear to be typical of a Southern group.

Eatonia and *Cingulopsis* are here restricted in a subfamily, the Cingulopsinae, to keep them distinct from a second and apparently

related group containing *Eatoniopsis* Thiele. The main characteristics of the Cingulopsinae have been fully discussed by Fretter and Patil (1958).

Subfamily **CINGULOPSINAE** Fretter and Patil, 1958, nom. transl. (ex **Cingulopsidae**).

Genus **EATONINA** Thiele, 1912

Type (monotypy): *E. pusilla* Thiele, 1912

Shell: Small, rather solid, uniform brown, banded, or spotted, whorls convex to nearly flat, apex blunt, aperture rounded, perforate or imperforate.

Animal: Cephalic tentacles, rather long, blunt, minutely setose. Posterior mucous slit extends from middle of sole to posterior end. No caudal tentacle.

Operculum: Rather thick, transparent, with a strong peg and a strong internal ridge.

Radula: Central small, not cuspate. Lateral large, 1-3 large cusps, sometimes with small denticles. Inner marginal with 0-4 cusps, outer with 1-4 cusps.

Subgenus **Eatonina**

Shell: Rather large for genus, whorls weakly convex, spire conic, aperture circular, imperforate, banded or uniform brown (type banded).

Animal: Typical of the genus. Fully described under *E.* (*E.*) *micans.*

Operculum: Oval. Muscle insertion area fairly distinct but transparent. Peg short.

Radula: Central small, with blunt processes. Lateral 1-3 large cusps (3 in type). Inner and outer marginals with 3 cusps.

Though *E. micans* differs from *E. pusilla* in a few minor radula details, these are not sufficient to warrant subgeneric distinction.

Eatonina (Eatonina) micans Webster. **Plate 15, figs. 1-4.**

1905 *Rissoa micans* Webster, Trans. N.Z. Inst. 37 (1904, 1905), p. 277, pl. 19, fig. 4.
1913 *Rissoa* (*Setia*) *micans* Webster; Suter, Man. N.Z. Moll. p. 214, pl. 12, fig. 24.
1915 *Notosetia micans* (Webster); Iredale, Trans. N.Z. Inst. 47, p. 454.

Shell rather large for genus, solid, imperforate; spire moderately tall, blunt; whorls weakly convex; protoconch smooth, flatly dome-shaped, not clearly marked off, about 1½ whorls. Surface dully shining, smooth, dark orange or reddish brown, fresh specimens sometimes almost black. Suture false-margined below by a dark spiral band. Outer lip colourless and thin in a narrow zone behind. Columella stands out from base, sometimes forming a minute umbilical chink. Aperture circular; peristome moderately thickened, continuous; anteriolateral part of outer lip slightly excavated, bent downwards posteriorly.

Animal: (Fig. 2). (Narrow Neck). Exposed parts reddish-orange, becoming paler when fully extended. Sole is dense pinkish-white. Cephalic tentacles semi-transparent white, rather short and stout, with blunt tips, continuously mobile. Eyes large, in prominent swellings at outer base of tentacles, a dense group of mucous glands behind. Snout rather short, bilobed, a cluster of large orange-red granules between eyes. Buccal mass brown. Foot fairly long, squarish in front, slightly constricted just behind anterior end, rounded behind. Posterior mucous gland in middle of sole, mucous slit extends to posterior end of foot. Anterior mucous gland bilobed, opening between pro- and mesopodium. Cilia beat posteriorly over lower part of snout and sole. Opercular lobe simple.

Operculum: (Fig. 3). Dark reddish-brown in living animal as opercular lobe visible through the transparent yellowish operculum. Rather strongly convex, oval, nucleus minute; peg stout, blunt and fairly short, with a thin lamella on distal end which emerges diagonally from the operculum. Internal ridge very thick. Muscle insertion area inside ridge, does not extend to outer edge. A weak, narrow ridge runs diagonally for a short distance from inner end of peg.

Radula: (Fig. 4). Short and broad, the teeth very large but delicate. Central small, with a very small median knob and two small, lateral processes. A pair of processes extend below. Lateral large, one very large cusp but no other cusps or denticles. Inner marginal large, with three denticles on outer side of a cusp, and a cusp-like process below cusp. Outer marginal small, with three denticles.

Holotype: (Fig. 1). Takapuna (A.M.).
Height 1.5 mm. Width 1.0 mm.

Material Examined:

Holotype and paratypes; Spirits Bay, shell sand (Hipkins Coll.); Taupo Bay, Whangaroa, 2/1/54 (Hipkins Coll.); Tapeka Point, Russell, -/1/52 (Hikins Coll.); Taurikura Bay, Whangarei Heads, *Corallina*, 15/5/61 (W.F.P.); MacGregor's Bay, Whangarei Heads, under stones (W.F.P.); Smuggler's Bay, Whangarei Heads, shell sand, 6/5/62 (W.F.P.); Bream Tail *Corallina*, 21/8/63 (W.F.P.); Shoal Bay, Great Barrier Island, algae, 6/1/51 (Hipkins Coll.); Okupu, Great Barrier Island, under stones, *Corallina*, fine algae, 24/11/63 (W.F.P.); Goat Island Bay Leigh, under stones, *Corallina*, *Carpophyllum* (W.F.P.); North side of Tawaranui Point, under stones on papa platform, 31/12/63 (W.F.P.); Waiwera, brown algae, 16/2/64 (W.F.P.); off Otata Island, Noises Group, 4 fathoms, 15/5/63 (W.F.P.); Takapuna, Auckland, *Carpophyllum* in pools, under stones, *Corallina*, 1962-64 (W.F.P.); Narrow Neck Reef, Auckland, *Corallina*, 1962-64 (W.F.P.); Auckland Harbour, Finlay Coll. (A.M.); Sandy Bay, Coromandel, *Corallina*, 30/3/64 (W.F.P.); Stony Bay, Coromandel, *Corallina*, short algae, 28/3/64 (W.F.P.); Jackson's Bay, Coromandel, *Corallina*, 29/3/64 (W.F.P.).

Distribution: The North East of the North Island in the lower littoral zone and down to a few fathoms.

Ecology: *P. micans* usually lives amongst algae in the lower littoral zone. In some areas it is very common in *Corallina*, while nearby in apparently similar conditions, it may be quite scarce, for example as seen in parts of Taurikura Bay. Living specimens were common in a dredging from off Otata Island, Noises Group, with the related species, *E. subflavescens*, even more abundant. The sediment consisted of coarse sand and *Tawera* valves.

Subgenus **OTATARA** n. subgen.

Type (o.d.) *Notosetia subflavescens* Iredale, 1915 (nom. nov. for *R. atomus* Suter, 1908, non Smith).

Though the shells of *E. micans* and *E. subflavescens* are similar, the radula is very different, so that at least subgeneric distinction for the latter species is warranted. The characteristics of the subgenus are those of *E. (O.) subflavescens,* which is described below.

Eatonina (Otatara) subflavescens Iredale. Plate 15, figs. 5-8.

1908 *Rissoa atomus* Suter, Proc. Mal. Soc. Lond., 8, p. 30, pl. 2, fig. 27.
1913 *Rissoa* (*Setia*) *atomus* (Suter); Suter, Man. N.Z. Moll. p. 212, pl. 12, fig. 20.
1915 *Notosetia subflavescens* Iredale, (nom. nov. for *R. atomus* Suter, 1908, non Smith), Trans. N.Z. Inst. 47, p. 453.
1933 *Notosetia subflavescens* Iredale; Powell, Rec. Auck. Inst. Mus. 1 (4), p. 199, pl. 34, fig. 8, (lectotype).
1955 *Notosetia subflavescens* Iredale; Powell, D.S.I.R., Cape Exped. Series Bull., 15, p. 85.

This species was originally described from rather poorly preserved material from off the Bounty Islands, and I have seen very little other material from this area. However shells that are almost identical with Bounty Island specimens are found in the North East of the North Island, and are here tentatively recognised as the same species.

The shell is variable in size, the relative height of the spire, and, the convexity of the whorls. This species differs from *E. micans,* which it resembles closely, in having a shorter spire, a proportionately larger body whorl, more convex whorls, and a relatively larger aperture which is angled anteriorly making it pyriform rather than circular. Also the inner lip above the columella is slightly convex, not concave as in *E. micans,* and the shell is usually lighter in colour, being yellowish-brown to reddish-brown. The shell is imperforate, but a narrow chink between the rather thickened columella and base sometimes has the appearance of a narrow umbilicus. *E. atomaria* has a shorter spire, a thinner shell, and more strongly convex whorls.

Animal: (Off Otata Island). External coloration greyish to white, semi-transparent, except sole which is dense white. Cephalic tentacles minutely setose, not tapering, rather thick, not very active; eyes at outer bases of tentacles, with a short, white, triangular patch behind them. Snout bilobed, expanded anteriorly, granular except for anterior edge, anterior end of oral tube bright red. Opercular lobe simple. Sole with a mucous slit extending from posterior end for about two-thirds of its length. A ciliated strip on right side of body, just behind eyes.

Operculum: (Fig. 7). Pale reddish-brown in the living animal. Generally similar to *P. micans,* yellowish, semi-transparent, rather strongly curved, with a muscle insertion area on outer side of a strongly thickened, but transparent, internal ridge. Peg short, broad, bilobed. An oblique dense ridge terminates upper end of the muscle insertion area. Growth lines weak. Nucleus very small.

Radula: (Fig. 8). Broad and short, with large delicate teeth. Central tiny with a median knob and weak lateral ridges. Lateral with a single large cusp. Inner marginal simple, curved; outer marginal small, triangular, with a broad base.

Lectotype: (Fig. 5). Bounty Islands, in 50 fathoms (Captain Bollons) (G.S.).

Height 1.225m. Width 0.875 mm.

Material Examined:

Lectotype; paralectotypes (D.M.); N.Z.O.I. Stat. C. 760, 34° 10.8' S., 172° 8.4' E., fathoms, bryozoan substrate, 18/2/62 (O.I.); Dredged off the Mokohinau Islands (W.F.P.); 25 fathoms, Hen and Chickens, Finlay Coll. (A.M.); Great Barrier Island, 8-10 fathoms, R. K. Dell Coll. (D.M.); Taurikura Bay, Whangarei Heads, shell sand (W.F.P.); off Otata Island, Noises Islands, 4 fathoms, 15/5/63 (W.F.P.); Mt. Maunganui-Mayor Island area, in fish stomach contents, G. Williams (Powell Coll.); off Bounty Islands (Powell Coll.).

Distribution: The North East of the North Island, and the Bounty Islands, in shallow to moderately deep water. The large gap in the known distribution will possibly be filled in with more intensive collecting, but it is more probable that the Northern form deserves subspecific status.

Subgenus **SAGINOFUSCA** n. subgen.

Type: *Notosetia atomaria* Powell, 1933.

Shell: Small, reddish-brown, spire broadly conical, approximately same height as aperture, whorls strongly convex, false-margined, smooth. Periphery and base rounded, umbilicate. Aperture nearly circular, very slightly angled above, peristome continuous, a little thickened.

Animal: Cephalic tentacles long, slender, very finely setose not tapering, with blunt tips, eyes on prominent swellings at their outer bases. Snout deeply bilobed, small. Foot moderately elongate, sole with mucous slit in mid-posterior half extending to posterior end. Opercular lobe simple.

Operculum: Transparent but solid, with a very thick internal ridge extending from a rather blunt, wide peg to right end, and not far in from columellar edge. Nucleus very small. Muscle insertion area indistinct.

Radula: Very short and wide with large, but rather delicate, teeth. Central small, no true cusps but only short blunt processes. Lateral tooth large, roughly rectangular, main cusp large, 3 + 1 + 3 (or 2). Inner marginal wide, with 4 large cusps. Outer marginal much smaller, 3-4 small cusps.

The species of this subgenus are characterised by their globose, reddish-brown shells, which are simple in build and appearance. The convex whorls and short spire separate *Saginofusca* from *Otatara* and *Eatonia* (sensu stricto) though the different radula structure is the most important characteristic.

Eatonina (Saginofusca) atomaria (Powell). Plate 15, figs. 9-12.

1933 *Notosetia atomaria* Powell, Rec. Auck. Inst. Mus. 1 (4), p. 198, pl. 34, fig. 9.
1962 *Notosetia atomaria* Powell; Smith, Rec. Dom. Mus. 4 (5), pp. 51-52, fig. 6.

This small shell is easily recognised by its short spire, and dark brown colour. Other distinguishing features are the imperforate to narrowly umbilicate base, rounded aperture, and the very convex whorls which become rather loosely coiled in large specimens (see Smith (1962) fig. 6). Most shells encountered, however, are rather small and compact.

Though originally described from the Chatham Islands, this species was recently recorded by Smith (1962) from Stewart Island. I have found it to be abundant in many parts of New Zealand, and especially so in the Hauraki Gulf where it is usually confused with *E. micans* by collectors.

Animal: (Fig. 10). (West Tamaki Heads). Exposed parts white. Cephalic tentacles constantly active, not tapered, with blunt tips, covered with very short stationary cilia. Eyes large, on prominent swellings at outer bases of tentacles. Snout deeply bilobed, rather small. Anterior margin of foot slightly concave, with a propodium and a fairly extensive anterior mucous gland. Posterior mucous gland opens into a long slit which runs through mid posterior part of sole. Opercular lobe simple.

Operculum: (Fig. 11). Semi-transparent, but rather solid, strongly curved, pear-shaped, nucleus minute, with a strongly thickened internal ridge, peg short, blunt, with a thin flange. Only very faint growth lines visible.

Radula: (Fig. 12). Short and broad, with large, but rather delicate, teeth. Central small, with blunt, short processes. There are two short, processes which are on middle part of dorsal edge, a single process on each side of these, and two more below each outer process. Lateral with one main cusp, three small denticles internal to this and three on outer side. Inner marginal curved, with four cusps and a wide basal portion; outer marginal small, with four cusps.

Holotype: (Fig. 9). Waitangi, Chatham Islands (A.M.).
Height 1.2 mm. Width 0.95 mm.

Material Examined:

Holotype and paratypes; Spirits Bay in shell sand (Hipkins Coll.); Taupo Bay, Whangaroa, shell sand, E. R. Richardson, 11/4/51 (D.M.); Taupo Bay, (Hipkins Coll.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.); Poor Knights Islands, under stones in pools, brown algae, 4/4/64 (W.F.P.); MacGregor's Bay, Whangarei Heads, algae, 22/5/63 (W.F.P.); Taurikura Bay, Whangarei Heads, *Corallina*, 18/5/61 (W.F.P.); Bream Tail, in *Corallina*, *Carpophyllum* in rock pools, under stones, 21/8/63 (W.F.P.); Laing's Beach, Mangawai, shell sand (Hipkins Coll.); Goat Island Bay, Leigh, *Corallina*, brown algae, under stones, 1/1/64 (W.F.P.); Tawharanui Point, North and South side, under stones, *Corallina*, 31/12/63 (W.F.P.); Waiwera, *Corallina*, 16/2/64 (W.F.P.); Campbell's Bay, Auckland, *Caulerpa*, W. Ballantine (W.F.P.); Takapuna, Auckland, *Corallina*, 1962-64 (W.F.P.);; Narrow Neck Reef, Auckland, *Corallina*, 1962-64 (W.F.P.); Point Chevalier, Auckland, algae, R. K. Dell (D.M.); West Tamaki Heads, Auckland, *Corallina*, -/8/62 (W.F.P.); West of Cornwallis, Manukau Harbour, *Corallina*, 7/1/62 (W.F.P.); Jackson's Bay, Coromandel, *Corallina*, 29/3/64 (W.F.P.); Stony Bay, Coromandel, *Corallina*, short algae, 28/3/64 (W.F.P.); Tolaga Bay, R. K. Dell, 28/11/50 (W.F.P.); Days Bay, Wellington Harbour, algae, 11/12/61 (W.F.P.); Island Bay, algae (D.M.); Paremata Harbour, 1957 (W.F.P.); Bluegum Point, Kenepuru Sound (W.F.P.); Tahunanui, Nelson (Powell Coll.); Gollan's Bay, Lyttelton Harbour, brown algae, W. R. B. Oliver, 26/3/10 (D.M.); Ships' Channel side of Quarantine Island, Dunedin Harbour, *Corallina*, soft brown algae, 4/9/63 (W.F.P.); Portobello, Dunedin Harbour, under stones, soft red algae, 3/9/63 (W.F.P.); Taieri Beach Otago, algae, Finlay Coll. (A.M.); Fish Rock, Foveaux Strait, 30 fathoms, O. Allan, -/6/51 (D.M.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.); Thule, Paterson Inlet, Stewart Island, algae at low spring tide, -/1/50 (Smith Coll.); Aker's Point, Halfmoon Bay, Stewart Island, 22/2/63, M. Spong (W.F.P.); Waitangi, Chatham Islands, algae on rocks between tides, W. R. B. Oliver, -/12/09 (D.M.); Waitangi, low tide, W. R. B. Oliver, 8/12/09 (D.M.); Red Bluff, Chatham

Islands, W. R. B. Oliver, 6/12/09 (D.M.); Chatham Island Exped. Stn. 38, South of Little Mangere, 43 fathoms, M.V. "Alert", 2/2/54 (D.M.).

Distribution: The East Coasts of the North and South Islands, West Coast Harbours of the North Island, Stewart Island, and the Chatham Islands, on algae in the lower littoral zone.

Eatonina (Saginofusca) maculosa n. sp. Plate 15, figs. 13-15.

Shell small, depressed, helicoid, umbilicate, brown, with rows of white spots, of $3\frac{1}{4}$ whorls. Protoconch smooth, with a yellowish tip, rest brown, slightly convex, of $1\frac{1}{4}$ whorls. Adult whorls strongly convex, dark brown, with two rows of white square shaped spots, one just above the periphery, another just below, lower row developed somewhat later. About 13 spots in the upper spiral series on body whorl. Umbilicus wide, deep, dark red brown in colour. Whorls narrowly margined with dark red brown, and columella also this colour. Aperture angled slightly posteriorly. Inner lip slightly convex a little detached from body whorl; columella concave, rather thickened. Outer lip with a distinct posterior cleft at suture, produced forward slightly below this, retracted anteriorly, margin yellow, semi-transparent.

Animal and Operculum: Very similar to *E. atomaria*.

Radula: Very similar to *E. atomaria*. Central with a pair of dorsal knobs, and an inner and outer pair of short processes below dorsal edge, and two pairs of short basal processes. Lateral 2 + 2 + 2, the third and fourth cusps rather large, others small. Inner marginal with 4 cusps, outer marginal with 3 cusps.

Holotype: Poor Knights Islands, on the undersides of masses of the vermetid *Novastoa lamellosa* (Hutton), 4/4/64, W.F.P. (A.M.).

Height 0.775 mm. Width 0.8 mm.

Material Examined:

Holotype and paratypes; Poor Knights Islands, under stones in rock pools, hard coralline algae, 4/4/64 (W.F.P.); Tawharanui Point, South side, under stones, 31/12/63 (W.F.P.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.), Tryphena, Great Barrier Island, shell sand, 1951 (Hipkins Coll.).

Distribution: The North East of the North Island. A rather rare species.

Subfamily EATONIOPSINAE n. subfam.

(Type genus *Eatoniopsis* Thiele, 1912 (*Eatoniella paludinoides* (Smith, 1902)).

Genera similar to *Eatoniopsis* appear to form a natural group, with clear cut shell, radula and opercular characters. Though the operculum bears a peg-like process, this is but weakly developed and, in view of the repeated occurrence of opercular pegs in various groups, it should not be considered a primary feature in classification. The radula, which is a much better guide to relationship, shows affinity with that of *Cingulopsis* and *Eatonina,* in that the central tooth is relatively small and the lateral large, but the radula, as a whole, is much smaller and differs in many details. The operculum of *Eatonia* bears a peg, but is of a different type from that of the Cingulopsinae.

Though details of the anatomy of *Rufodardanula* (nov.) are largely unknown, the male is aphallate and the stomach is fairly large and sacular and therefore in contrast to the minute, U-shaped stomach of the Cingulopsinae. Until more details of the anatomy are at hand, the creation of a family for this group seems unwarranted.

Animal: Exposed parts similar to that of the Eatoniellidae and Cingulopsidae. Cephalic tentacles long, not tapering, minutely setose; eyes large, in swellings at outer bases of tentacles. Snout short, bilobed. Foot with a distinct propodium and a long, well developed, mucous slit extending from centre of sole to posterior end. Posterior mucous gland distinct. Opercular lobe simple and no accessory tentacles. Male aphallate.

Operculum: Oval to nearly circular, thin, transparent, flexible. Peg small, sometimes rudimentary, growth lines very distinct.

Radula: Ribbon small. Central tiny, with 1-3 cusps, lateral large, with many cusps; marginal long, with few or many cusps.

Boogina Thiele, 1913, is also a member of this subfamily.

"Eatoniopsis" ainsworthi Hedley does not 'neatly' fit into any genus on shell characters. It can, however, be tentatively included in *Ovirissoa* (Rissoidae).

Genus RUFODARDANULA n. gen.

(Type: *R. spadix* n. sp.)

Subgenus **Rufodardanula**

Shell: Minute, reddish brown, thin and fragile, smooth, broadly conical; whorls, periphery and base convex; narrowly umbilicate. Aperture small, angled posteriorly, columella vertical, with a weak swelling above; peristome continued as a thin glaze across parietal wall.

Animal: As described for the family.

Operculum: Oval, thin, transparent, colourless; columella margin broad; peg small but solid, extending past columellar margin. Growth lines prominent.

Radula: Central small, square, with one cusp and lateral thickenings. Lateral large, with about 12 small cusps; marginals long, pointed, with a wide base, minutely serrate.

Rufodardanula (Rufodardanula) spadix n. sp. Pl. 15, figs. 1-4.

Shell very small, reddish-brown, thin, ovate-conic, smooth. Whorls 4, convex sutures, false-margined with a dark band; protoconch smooth, not marked off from succeeding whorls; body whorl large, periphery and base convex. Aperture moderately large, columella nearly vertical, with a weak swelling; peristome continuous, not thickened; outer lip thin, very little retracted. Umbilical chink very small. Colour reddish-brown, a dark band below sutures, and dark around umbilical area and on columella.

The new species differs from R. (*T.*) *exigua* n. sp., which is of similar size, by having a broader shell with more convex whorls. The two species are nearly identical in colour and general shell features.

Animal: (Leigh) (Fig. 2). As described for the family. Not pigmented.

Operculum: (Fig. 3) and *Radula* (Fig. 4): As described for the subgenus.

Holotype: (Fig. 1). Goat Island Bay, Leigh, *Corallina*, 1/1/64, W.F.P. (A.M.).

Height 0.9 mm. Width 0.6 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; N.Z.O.I. Stat. C. 760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.); Taupo Bay, shell sand, 2/1/54 (Hipkins Coll.); Poor Knights Islands, under stones in pools, 4/4/64 (W.F.P.); Kaitoke, Great Barrier, short algae, 16/11/63 (W.F.P.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.); Tawharanui Point, North side, under stones on papa platform, 31/12/63 (W.F.P.); Narrow Neck Reef, Auckland, *Carpophyllum plumosum* in rock pool, 26/3/63 (W.F.P.).

Distribution: The far North and North-East of the North Island.

Subgenus **TUBBREVA** n. subgen.

Type: *Rufodardanula* (*Tubbreva*) *exigua* n. sp.

Shell very similar to *Rufodardanula*, though often more elongate and imperforate.

Operculum: Similar to that of *R.* (*R.*) *spadix*, but has a very short, almost rudimentary peg, which is only slightly thickened, and has a more expanded columella edge.

Radula: Very minute or absent as it has defied all attempts at mounting. Until anatomical and radula characters are known, *Tubbreva* is considered to be subgeneric to *Rufodardanula*.

Rufodardanula (Tubbreva) exigua n. sp. Plate 16, figs. 5, 6.

1962 *Notosetia* sp. (discussed in relation to *N. exaltata* Powell) Smith, Rec. Dom. Mus. 4 (5), p. 52.

Shell minute, thin, fragile, smooth, red-brown, elongate-conic, imperforate. Whorls $4\frac{1}{4}$, weakly convex, protoconch dark red-brown, smooth, small, not distinctly marked off. Sutures false-margined by a dark, red-brown, narrow band; body whorl not swollen, periphery and base rounded. Aperture rather large, angled above and below, peristome thin, continuous, a thin glaze across parietal wall. Columella vertical, with a faint swelling above. In holotype and majority of specimens encountered outer lip thin, fragile, very slightly excavated, though occasional shells show some thickening of entire peristome. Colour reddish-brown on spire, a pale brown, indistinct band in middle of body whorl, periphery and base reddish-brown, darker below sutures and in umbilical area. Variation in size, shape, and convexity of whorls considerable.

Though superficially similar to the deepwater *R. minitula*, that species differs in having a blunter protoconch, nearly flat whorls, and

a rounded aperture. *R. exaltata* differs in its larger size, broader spire and heavier shell.

Animal: (Leigh). As described for family. Head and foot unpigmented. Very active, foot and tentacles highly mobile.

Operculum: (Fig. 6). Oval, thin, transparent, colourless, curved; columella edge strongly convex, extending to the left round peg and raised above nucleus, which is very small. Peg tiny, very little thickened, not extending over edge of operculum. Growth lines very strong and irregular.

Radula: Unknown.

Holotype: (Fig. 5). East of Purau, Lyttelton Harbour, on fine brown weed in rock pools between tides, W. R. B. Oliver, 4/9/10 (ex Dominion Museum) ex W.F.P. Coll. (A.M.).

Height 0.1 mm. Width 0.575 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Great Island, Three Kings Islands, sublittoral algae, A. Baker (W.F.P.); Spirits Bay, algae, W. R. B. Oliver, 1929 (D.M.); 12 fathoms, Doubtless Bay, Finlay Coll. (A.M.); Tapeka Point, Russell, algae, R. K. Dell (D.M.); Poor Knights Islands, under vermetid masses, hard coralline algae, 4/4/64 (W.F.P.); MacGregor's Bay, Whangarei Heads, shell sand, 9/4/55 (Hipkins Coll.) and algae, under stones, 22/5/63 (W.F.P.); Bream Tail, *Corallina*, 21/8/63 (W.F.P.); Kaitoke, Great Barrier Island, under stones, -/11/63 (W.F.P.); Tryphena, Great Barrier Island, 5-6 fathoms (Powell Coll.), 6 fathoms, A. W. B. Powell (D.M.) and shell sand, -/1/55 (Hipkins Coll.); Goat Island Bay, Leigh, *Carpophyllum plumosum, Corallina,* various short, soft algae, 1962-64 (W.F.P.); Tawharanui Point, North side, *Carpophyllum* in pools on papa platform, 31/12/63 (W.F.P.); Campbells Bay, Auckland, *Caulerpa,* W. Ballantine (W.F.P.); Brown's Bay, Auckland, brown algae, 19/1/64 (W.F.P.); Takapuna, Auckland, *Corallina, Carpophyllum plumosum,* 1962-64 (W.F.P.); West Tamaki Heads, Auckland, *Corallina,* -/8/62 (W.F.P.); Cornwallis, Manukau Harbour, *Corallina,* brown algae, 7/1/62 (W.F.P.); Jackson's Bay, Coromandel, *Carpophyllum plumosum,* fine red algae, 29/3/64 (W.F.P.); Sandy Bay, Coromandel, *Corallina,* 30/3/64 (W.F.P.); 35 fathoms, Tuhua Reef, Mayor Island, fish stomach contents, G. Williams (Powell Coll.); Cape Runaway, algae, A. W. B. Powell, -/8/33 (Powell Coll.); Tolaga Bay, shell sand, R. K. Dell, 28/11/50 (D.M.); Gisborne, shell sand, 1906 (D.M.); Lyall Bay, Wellington, *Cystophora,* W. R. B. Oliver, 18/12/21 (D.M.); Island Bay, Wellington, algae, -/9/27 (D.M.); algae, 28/2/59 (W.F.P.); Owhiro Bay, Wellington, *Corallina,* 29/2/63 (W.F.P.); Day's Bay, Wellington Harbour, algae, 11/12/61 (W.F.P.); Titahi Bay, *Corallina,* 11/12/61, and shell sand, -/11/55 (W.F.P.); Karehana Bay, Plimmerton, *Xiphophora,* 7/12/61 (W.F.P.); Brother's Island, Cook Strait, sublittoral algae, D. E. Hurley, -/5/51 (D.M.); Long Beach, Durville Island, in pools, W. R. B. Oliver, 13/2/43 (D.M.); Kaikoura, *Corallina,* R. A. Rusmussen, 12/6/64, fine brown algae, P. Luckens, 12/8/64 (W.F.P.); Oaro, South of Kaikoura, coralline algae, W. Ballantine, 19/2/64 (W.F.P.); Motanau Beach, Canterbury, coralline algae, R. R. Forster, 17/1/48 (D.M.); East of Purau, Lyttelton Harbour, fine coralline algae, and fine brown weed in rock pools between tides, W. R. B. Oliver, 4/9/10 (D.M.); Gollan's Bay, Lyttelton Harbour, *Perna* zone, brown algae, W. R. B. Oliver, 26/3/10 (D.M.); Taylor's Mistake, Bank's Peninsula, *Cystophora,* soft coralline algae, in pools, W. R. B. Oliver, 10/4/10 (D.M.) and coralline algae, -/9/63 (W.F.P.); Okain's Bay, Bank's Peninsula, W. R. B. Oliver, 10/11/06 (D.M.); East of Diamond Harbour, Lyttelton Harbour, *Corallina,* -/9/63 (W.F.P.); Bushy Beach, Oamaru, coralline algae, 24/2/64 (W.F.P.); Little Papanui, Dunedin, coralline algae, red algae, 5/9/63 (W.F.P.); Portobello, Dunedin Harbour, brown and red algae, *Corallina,* 3/9/63 (W.F.P.); Ships' Channel side of

Quarantine Island, Dunedin Harbour, brown and fine red algae, *Corallina*, 4/9/63 (W.F.P.); Taieri Beach, Finlay Coll. (A.M.); Taieri River Mouth, coralline algae, W. Ballantine, 27/6/64 (W.F.P.); Foveaux Strait, oyster scrapings, 1957 (W.F.P.); Halfmoon Bay, Stewart Island, algae, E. Smith, 12/4/52 (W.F.P.); Halfmoon Bay, shell sand, O. Allan, -/1/47 (D.M.); Paterson Inlet, Stewart Island, algae, 15/9/56 (Smith Coll.); Thule, Paterson Inlet, Stewart Island, algae, 7/8/56 (Smith Coll.); Horseshoe Bay, Stewart Island, shell sand, -/12/57 (Smith Coll.).

Distribution: The North and South Islands, mainly restricted to the East Coast though it is known from the Cook Strait West Coast and the Manukau Harbour. It also occurs at Stewart Island. *R.* (*T.*) *exigua* inhabits finely-divided algae in the littoral and sublittoral.

Rufodardanula (Tubbreva) exaltata exaltata (Powell). Plate 16, figs. 8-11.

1933 *Notosetia exaltata* Powell, Rec. Auck. Inst. Mus. 1 (4), p. 198, pl. 34, fig. 5.
1962 *Notosetia exaltata* Powell; Smith, Rec. Dom. Mus. 4 (5), p. 52, fig. 8.

Typical *R.* (*T.*) *exaltata* is similar to *R.* (*T.*) *exigua* n. sp. but larger in size, with flatter whorls, heavier shell and with a bluntly rounded periphery.

Operculum: (Stewart Island). (Fig. 11). Similar to that of *R.* (*T.*) *exigua* but with a slightly heavier peg and the columella margin is a little less expanded.

Holotype: Off Owenga Beach, Chatham Islands, 10 fathoms, in clean shell sand (A.M.).

Height 1.55 mm. Width 0.9 mm. (from Powell)

Material Examined:

Paratypes; Days Bay, Wellington Harbour, algae, 11/12/61 (W.F.P.) (c.f. *exaltata*); Ships' Channel side of Quarantine Island, Dunedin Harbour, fine red, brown algae, *Corallina*, 4/9/63 (W.F.P.); Portobello, Dunedin Harbour, *Corallina*, red algae, 3/9/63 (W.F.P.); Portobello, 1-3 fathoms, 3/8/63 (W.F.P.); off Bragg's Point, Stewart Island, 40 fathoms, E. Smith, -/5/59 (D.M.); Butterfield's Beach, Stewart Island, shell sand, O. Allan, -/10/47 (D.M.); Bathing Beach, Stewart Island, shell sand, O. Allan, 1950 (D.M.); Paterson Inlet, Stewart Island, algae, -/1/50 (Smith Coll.); off Mouth of Halfmoon Bay, 8 fathoms, algae, -/4/59 (Smith Coll.); B.S. 107, Goal Passage, Doubtful Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 8/5/50 (D.M.); Doubtful Sound, 50 fathoms (W.F.P.); Chatham Islands Exped. Stat. 23, 43° 32.5' S., 176° 47.5' W., North of the Sisters, 33 fathoms, M.V. "Alert", 29/1/54 (D.M.); Chatham Islands Exped. Stat. 24, 43° 36.2' S., 176° 48.5' W., South of the Sisters, 38 fathoms, 29/1/54 (D.M.).

Distribution: The South Island, possibly restricted to the Southern half, Stewart Island, and the Chatham Islands, from low tide to moderately deep water.

Rufodardanula (Tubbreva) exaltata sorenseni (Powell). Plate 16, figs. 12, 13.

1955 *Notosetia sorenseni* Powell, D.S.I.R., Cape Exped. Series, Bull. 15, p. 87, pl. 3, fig. 20.

R. (*T.*) *exaltata sorenseni* is very similar to *R.* (*T.*) *exaltata*, differing only in the shorter spire which results in a relatively more inflated body whorl.

Operculum: (Campbell Island). (Fig. 13). Very similar to that of *R.* (*T.*) *exaltata*.

Holotype: (Fig. 12). Campbell Island, Cape Expedition, J. H. Sorensen, 1943 (A.M.).

Height 1.125 mm. Width 0.775 mm.

Material Examined:

Holotype and paratypes; 50 fathoms, Snares Islands, Finlay Coll. (A.M. and Powell Coll.); 6 fathoms, Emergency Bay, Carnley Harbour, Auckland Islands, Cape Expedition, C. A. Fleming (Powell Coll.); Campbell Island, Cape Expedition, J. H. Sorensen, 1943 (Powell Coll.); 50 fathoms, Bounty Islands, Finlay Coll. (A.M.).

Distribution: Snares, Auckland, Campbell and Bounty Islands, in shallow to moderately deep water.

Rufodardanula (Tubbreva) minutula (Powell). Plate 16, fig. 7.

1936 *Dardanula minutula* Powell, Discovery Rep., 15, p 204, pl. 53, fig. 14.

The operculum of this species is unknown, but the general shell features place it, with some degree of certainty, in *Tubbreva*. The shell can be distinguished from *R.* (*T.*) *exigua* n. sp., which is of similar size, by its flatter whorls and, especially, by the rather thicker shell. The aperture is smaller and more nearly circular than in *R.* (*T.*) *exigua*, and the columella swelling hardly visible. Rather strong growth striae are developed, and, in certain lighting, faint spiral lines can be seen in the semi-transparent shell. Animal, operculum and radula unknown.

Holotype: Discovery II Stat. 933, off the Three Kings Islands in 260 metres.

Height 0.95 mm. Width 0.55 mm. (from Powell)

Material Examined:

Paratypes (A.M.); N.Z.O.I. Stat. C. 760, 34° 10.8' S., 172° 8.4' E., off the Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.).

A SUMMARY OF THE NOMENCLATURAL CHANGES.

TROCHACEA

Fam. Liotiidae

Notosetia Iredale 1915. (*Barleeia neozelanica* Suter)
N. neozelanica Suter, 1898.
N. aoteana Powell, 1937.

RISSOACEA

Fam. Rissoidae

Subfam. Rissoinae

Rissoa (*Haurakia*) Iredale, 1915. (*Rissoa hamiltoni* Suter)
R. (*H.*) *aupouria* (Powell, 1937).
R. (*H.*) *infecta* (Suter, 1908).
Powellisetia n. gen. (*Rissoa porcellana* Suter).
P. bilirata n. sp.
P. crassilabrum (Powell, 1940).
P. gradata (Suter, 1908) (= *Notosetia fairchildi* Powell, 1933).
P. lineata (Smith, 1962).

P. microstriata (Murdoch, 1905) (= *Notosetia antipoda* Powell, 1955).
P. porcellana (Suter, 1908) (= *Rissoa stewartiana* Suter, 1908). (= *Dardanula convexispira* Powell, 1955).
P. porcellanoides (Powell, 1937).
P. retusa (Powell, 1927).
P. subgradata (Powell, 1937).
P. subtenuis (Powell, 1937) (= *Notosetia multilirata* Powell, 1940). (= *N. subcarinata* Powell, 1940). (= *N. foveauxana* Smith, 1962).
P. tenuisculpta (Powell, 1933).
P. unicarinata (Powell, 1930).
Austrorissopsis n. gen. (*Rissopsis brevis* May, 1919).
Rissopsis (*Peringiella*) Monterosato, 1878. (*Rissoa laevis* Monterosato).
R. (*P.*) *elegans* n. sp.
R. (*P.*) *lubrica* (Suter, 1898).
R. (*P.*) *simplex* (Powell, 1927).
Ovirissoa Hedley, 1916 (*Rissoa adarensis* Smith, 1962)
O? ainsworthi (Hedley, 1916).

Fam. Cingulopsidae

Subfam. Cingulopsinae

Eatonina (*Eatonina*) Thiele, 1912. (*E. pusilla* Thiele, 1912).
E. (*E.*) *micans* (Webster, 1905).
E. (*Otatara*) n. subgen. (*Notosetia subflavescens* Iredale, 1915).
E. (*O.*) *subflavescens* (Iredale, 1915).
E. (*Saginofusca*) n. subgen. (*Notosetia atomaria* Powell, 1933).
E. (*S.*) *atomaria* (Powell, 1933).
E. (*S.*) *maculosa* n. sp.

Subfam. Eatoniopsinae

Rufodardanula n. gen. (*R. spadix* n. sp.).
R. (*Rufodardanula*) n. subgen.
R. (*R.*) *spadix* n. sp.
R. (*Tubbreva*) n. subgen. *R.* (*T.*) *exigua* n. sp.).
R. (*T.*) *exigua* n. sp.
R. (*T.*) *exaltata exaltata* (Powell, 1933).
R. (*T.*) *exaltata sorenseni* (Powell, 1955).
R. (*T.*) *minutula* (Powell, 1936) (*Dardanula*).

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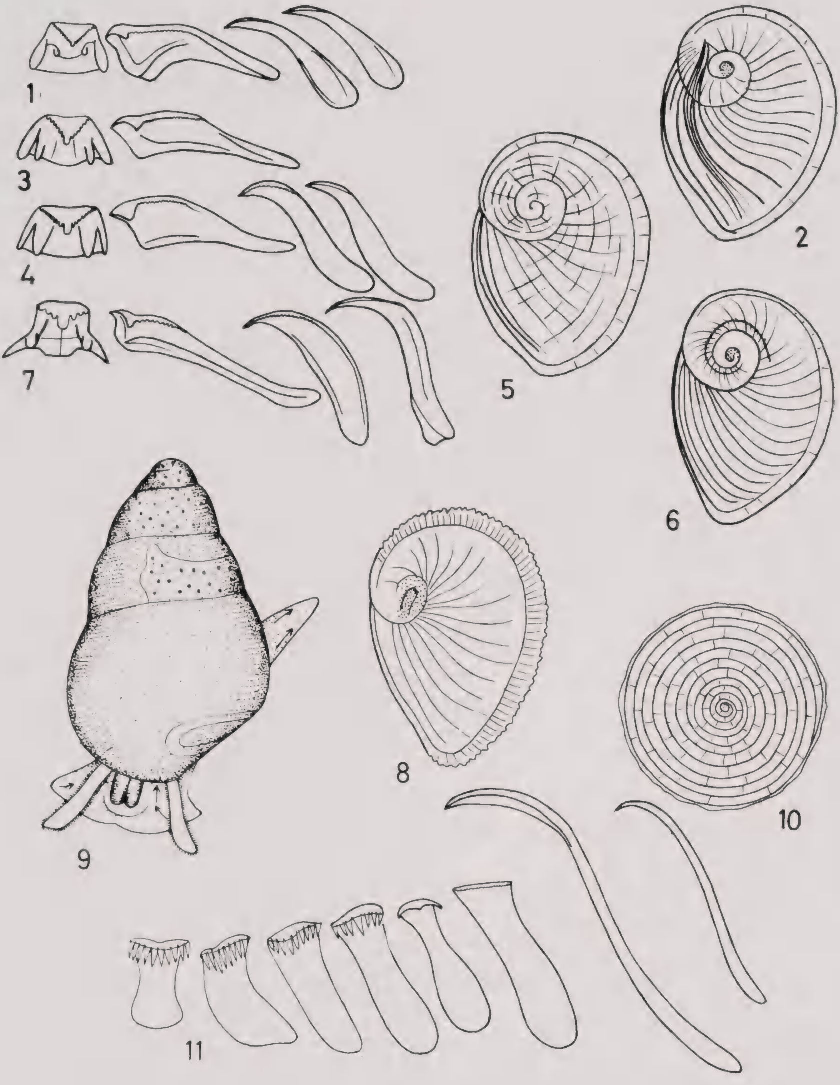
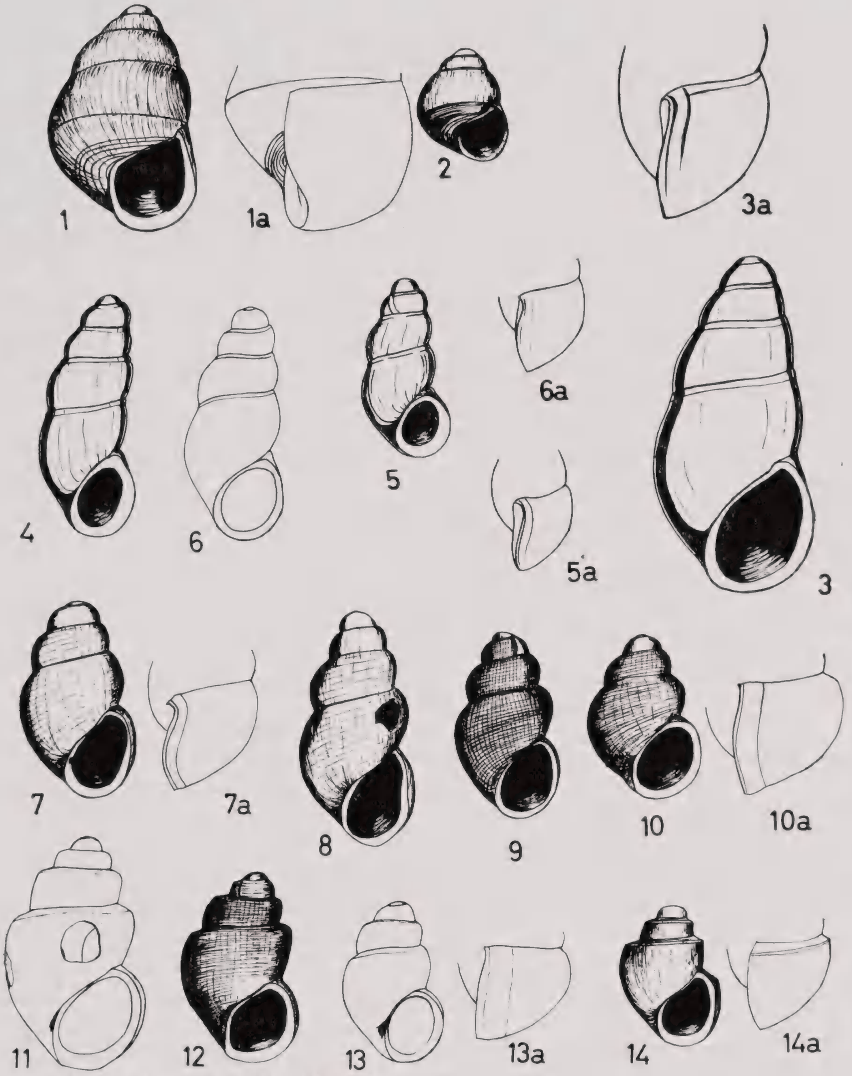
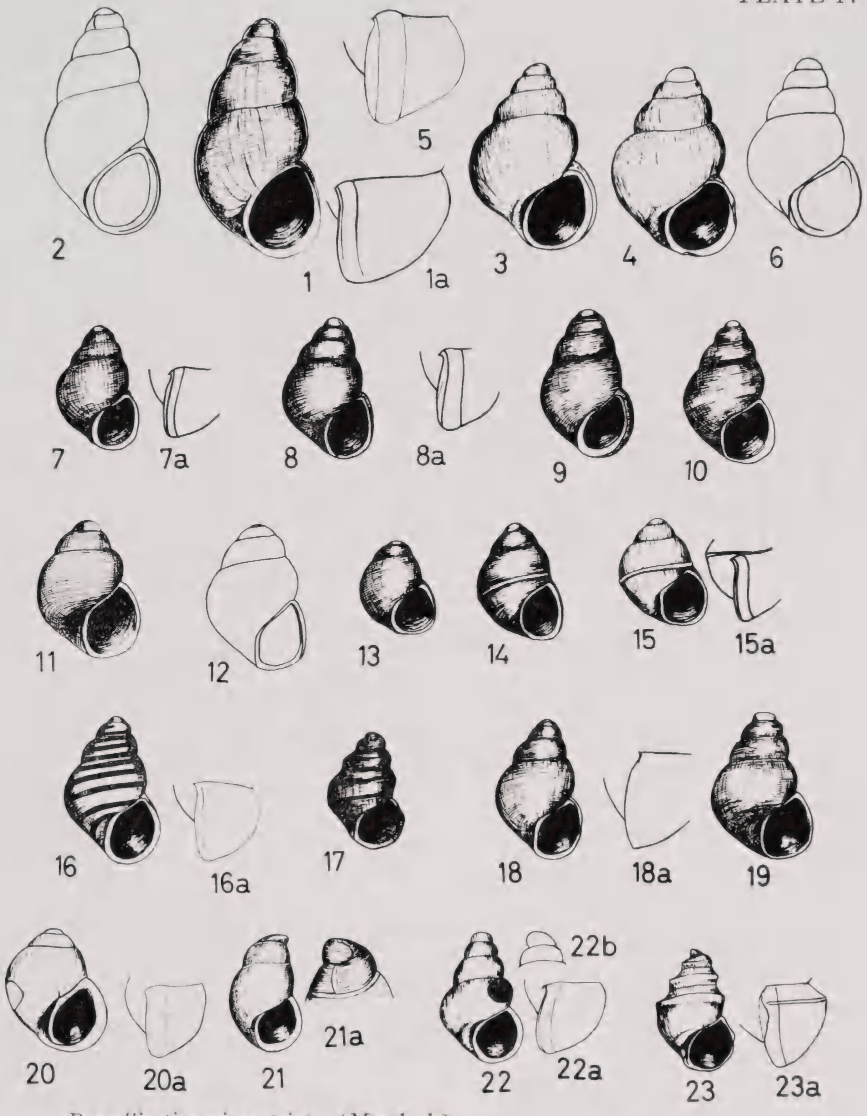


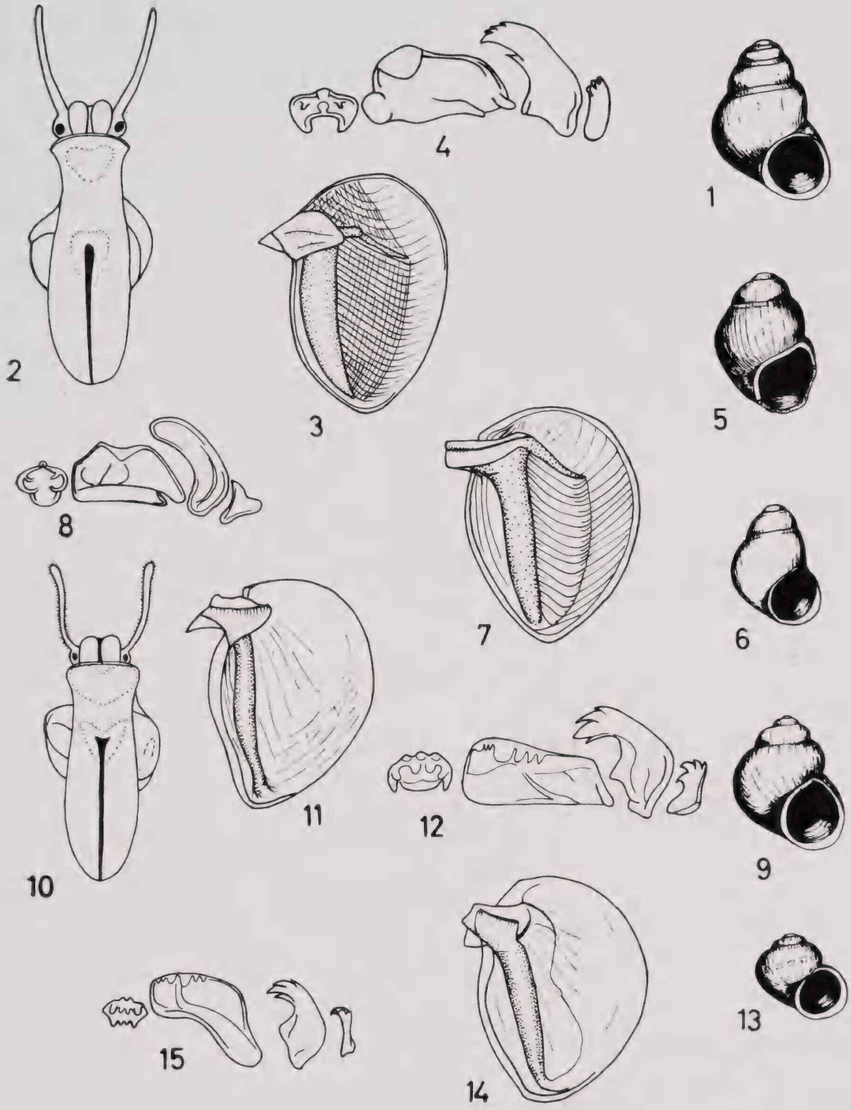
Powellisetia porcellana (Suter)
Fig. 1. Radula.
2. Operculum (inner side).
Powellisetia tenuisculpta (Powell)
3. Central and lateral teeth of the radula.
Powellisetia subtenuis (Powell)
4. Radula.
5. Operculum (inner side).
Powellisetia porcellanoides (Powell)
6. Operculum (inner side).
Rissopsis (*Peringiella*) *elegans* n. sp.
7. Radula. 8. Operculum (inner side).
Powellisetia subtenuis (Powell)
9. Dorsal view of the living animal.
Notosetia neozelanica (Suter)
10. Operculum (inner side).
11. Radula.



Notosetia neozelanica (Suter)
Fig. 1, 1a. Paralectotype 2.05 x 1.4 mm.
Notosetia aoteana Powell
2. Paratype 1.0 x 0.8 mm.
Rissopsis (*Peringiella*) *elegans* n. sp.
3, 3a. Holotype 3.1 x 2.15 mm.
Rissopsis (*Peringiella*) *lubrica* (Suter)
4. Foxeaux Strait 2.225 x 0.875 mm.
5, 5a. Foveaux Strait 1.65 x 0.775 mm.
6, 6a. Paratype of *Notosetia benthicola* Powell 2.15 x 0.9 mm.
Powellisetia retusa (Powell)
7, 7a. Holotype 1.825 x 1.05 mm.
8. Paratype 2.2 x 1.05 mm.
Powellisetia gradata (Suter)
9. Bounty Islands, 170 fathoms 1.75 x 0.95 mm.
10, 10a. Holotype of *Notosetia fairchildi* Powell 1.525 x 1.05 mm.
11. Paratype 2.175 x 1.3 mm.
12. 30 fathoms off Halfmoon Bay, Stewart Island 1.775 x 1.1 mm.
13, 13a. 30 fathoms off Halfmoon Bay, Stewart Island 1.5 x 0.9 mm.
Powellisetia subgradata (Powell)
14, 14a. Paratype 1.3 x 0.925 mm.



Powellisetia microstriata (Murdoch)
Fig. 1, 1a. 30 ıathoms, off Halfmoon Bay, Stewart Island 2.15 x 1.25 mm. Fig. 2. Holotype of *Notosetia antipoda* Powell.
Powellisetia porcellana (Suter)
Fig. 3. Paratype 1.675 x 1.15 mm. Fig. 4. Lectotype of *Notosetia stewartiana* (Suter) 1.7 x 1.25 mm. Fig. 5. Off Port William, Stewart Island. Fig. 6. Holotype of *Dardanula convexispira* Powell 1.6 x 1.0 mm.
Powellisetia subtenuis (Powell)
Fig. 7, 7a. Paratype 1.125 x 0.7 mm. Fig. 8, 8a. Off Port William, Stewart Island, 1.275 x 0.8 mm. Fig. 9. Hen and Chicken Islands, 25 fathoms, 1.35 x 0.825 mm. Fig. 10. 30 fathoms, off Poutama Island, South Cape, Stewart Island (= *tenuisculpta* of Smith) 1.3 x 0.8 mm.
Fig 11. Paratype of *Notosetia foveauxana* Smith 1.225 x 0.9 mm.
Fig. 12. 12 fathoms, Doubtless Bay 1.3 x 0.875 mm. Fig. 13. Holotype of *Notosetia multilirata* Powell 0.825 x 0.65 mm. Fig. 14. 100 fathoms, off Big King Island, Three Kings Islands 1.075 x 0.725 mm. Fig 15, 15a. Holotype of *Notosetia subcarinata* Powell 1.0 x 0.75 mm.
Powellisetia lineata (Smith). Fig. 16, 16a. Paratype 1.35 x 0.85 mm. *Powellisetia bilirata* n. sp. Fig. 17. Holotype 1.05 x 0.675 mm. *Powellisetia tenuisculpta* (Powell). Fig. 18, 18a. Holotype 1.25 x 0.75 mm. Fig. 19. Off Port William, Stewart Island 1.325 x 0.9 mm. *Powellisetia crassilabrum* (Powell). Fig. 20, 20a. Holotype 1.1 x 0.9 mm. *Powellisetia* c.f. *porcellanoides* (Powell). Fig. 21, 21a. 12 fathoms, Awanui Bay 1.05 x 0.625 mm. *Powellisetia porcellanoides* (Powell). Fig. 22, 22a, 22b. Paratype 1.2 x 0.725 mm. *Powellisetia unicarinata* (Powell). Fig. 23, 23a. Holotype 1.1 x 0.7 mm.

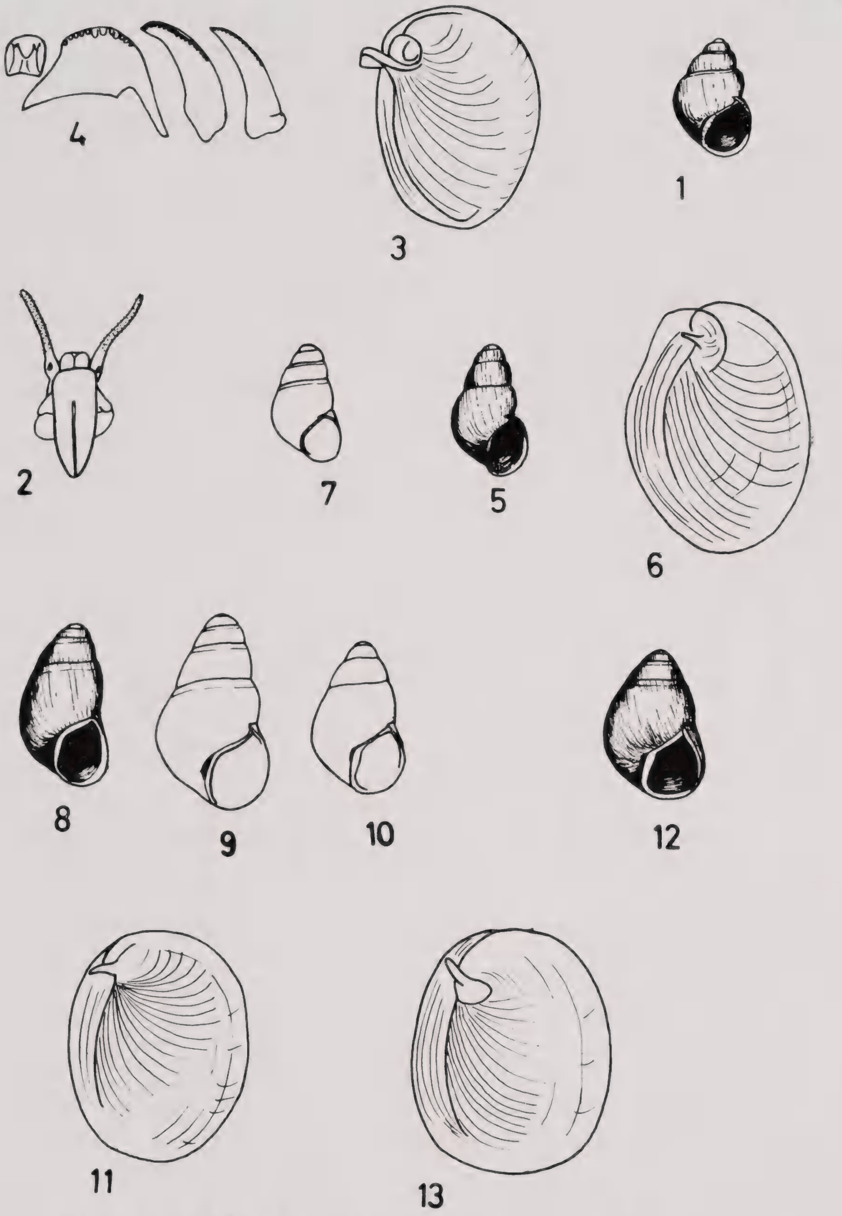


Eatonina (*Eatonina*) *micans* (Webster)
Fig. 1. Holotype 1.5 x 1.0 mm.
2. Ventral view of the living animal.
3. Operculum (inner side). 4. Radula.

Eatonina (*Otatara*) *subflavescens* (Iredale)
5. Lectotype 1.225 x 0.875 mm.
6. Off Otata Island, Noises Group, Hauraki Gulf, 1.05 x 0.75 mm.
7. Operculum (inner side). 8. Radula.

Eatonina (*Saginofusca*) *atomaria* (Powell)
9. Holotype 1.2 x 0.95 mm.
10. Ventral view of the living animal.
11. Operculum (inner side). 12. Radula.

Eatonina (*Saginofusca*) *maculosa* n. sp.
13. Holotype 0.775 x 0.8 mm.
14. Operculum (inner side). 15. Radula.



Rufodardanula (*Rufodardanula*) *spadix* n. sp.
Fig. 1. Holotype 0.9 x 0.6 mm. 2. Ventral view of living animal.
3. Operculum (inner side). 4. Radula.
Rufodardanula (*Tubbreva*) *exigua* n. sp.
5. Holotype 0.1 x 0.575 mm. 6. Operculum (inner side).
Rufodardanula (*Tubbreva*) *minutula* (Powell)
7. Paratype 0.9 x 0.5 mm.
Rufodardanula (*Tubbreva*) *exaltata exaltata* (Powell)
8. Paratype 1.225 x 0.65 mm. 9. Paratype 1.5 x 0.875 mm.
10. 8 fathoms, off Halfmoon Bay, Stewart Island 1.15 x 0.7 mm.
11. Operculum (inner side).
Rufodardanula (*Tubbreva*) *exaltata sorenseni* (Powell)
12. Holotype 1.125 x 0.775 mm. 13. Operculum (inner side).

A Revision of the New Zealand Recent and Fossil Species of Estea Iredale, 1915

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ABSTRACT

The genus *Estea* Iredale is described and the recent and fossil New Zealand species are reviewed. Details of the radulae, opercula, penes, and external appearances of the animals of several species are given. A new subgenus is created for *Estea angustata* Powell; several species are synonymised, and two new species are described. Five species previously included in the genus are excluded.

INTRODUCTION

The genus *Estea* has been used to cover a group of New Zealand and Australian shells of ovate-conical shape, with a smooth or sculptured surface, rounded aperture and thickened peristome. Australian workers have confused *Dardanula* and *Estea* (Cotton 1944, Laseron 1950), but these two entities are very different, belonging to quite different families (see Ponder, 1956a, b) *Estea* does not seem to have been recognised outside Australia and New Zealand, and Laseron (1956) does not record it from Northern Australia and Queensland. Wenz (1938) and Thiele (1929) do not recognise the genus, placing it as a synonym of *Pisinna* Monterosato. However *Pisinna* has a different aperture and is probably more closely related to *Cingula*, and therefore a true rissoid. *Estea*, on the other hand, belongs to a distinct group of subfamily status within the Rissoidae. In this revision 28 New Zealand species and subspecies are recognised and five species are discarded from the genus as previously recognised. These are:—

E. crassicarinata Powell, 1937 (Eatoniellidae) (see Ponder, 1965b).
E. crassicordata Powell, 1937 (new family) (see Ponder, —d).
E. gibbera Laws, 1950 (*Ovirissoa*, Rissoidae) (see Ponder, —c).
E. gracilispira Powell, 1933 (Eatoniellidae) (see Ponder, 1965b).
E. minitula Powell, 1933 (Eatoniellidae) (see Ponder, 1965b).

In this review, no attempt has been made to investigate the origins or relationships of the group outside New Zealand as I have not been able to see sufficient comparative material.

In New Zealand the genus first appears in the Middle Oligocene (Duntroonian) and there are a number of tertiary species, though the majority known are recent forms. No doubt, with increased collecting of microfossils, the group will become considerably larger and, perhaps, the ancestry of the recent forms will become evident. The state of our knowledge, at present, does not allow for much discussion on evolutionary lines as the fossil record is too fragmentary. A table is given in Appendix 1 of the distribution in time of the species of *Estea* and some tentative evolutionary sequences are suggested.

As many species of *Estea* are sculptureless and it is difficult to select a distinctive feature suitable for use in a key, no written key

is provided. However every species is illustrated, and this should prove a helpful guide in identification. The figures are all enlarged on the same scale so that an indication of relative size can be obtained.

A discussion in which *Estea* is considered in relation to allied genera is given by Ponder (—e).

The terminology and method used in the descriptions of the animal, operculum and radula is the same as that used by Ponder (1965b).

Abbreviations

A.M.—Auckland Museum. A.U. Geol. Dept.—Auckland University Geology Department. Coll.—Collection. D.M.—Dominion Museum. G.S. —Geological Survey. O.I.—Oceanographic Institute.

ESTEA Iredale 1915

Type (o.d.): *Rissoa zosterophila* Webster, 1898

Shell: Small, oval, elongate, subrimate, dull or shining, smooth or sculptured with spirals or axials. Spire higher than aperture, conical, outline slightly convex to straight, usually a fair number of whorls. Protoconch dome-shaped, usually reddish, about two whorls, surface minutely pitted in many spiral series. Base rounded to subangled; suture usually not much impressed. Aperture oval, oblique, slightly angled above; peristome continuous, much thickened within, but sharp edged. Columella short, callous.

Animal: Cephalic tentacles club-shaped, with stationary cilia terminally and a tract of posteriorly directed cilia on ventral surface. Eyes in bulges at outer bases of tentacles. Snout rather large, bilobed, mobile. Foot moderately long, a distinct groove on anterior edge is only indication of propodium, posterior mucous gland distinct, opens into slit situated in posterior half of sole. Opercular lobes simple. No accessory tentacles. Penis coiled, simple, attached to midline some distance behind head.

An account of the anatomy of two species of *Estea* is given by Ponder, —a.

Operculum: Thin, transparent, colourless, oval, nearly flat, nucleus small, indistinct. Marginal areas usually narrow; muscle insertion area typically distinct occupying the columella half, marked with irregular short lines, slightly thickened.

Radula: Central rather large, with a pair of long basal processes, cusps 1-2 + 1 + 2-1, large. Lateral rather small, cusps 2 + 1 + 2-3, large, with a long, narrow, outer portion. Marginals elongate, curved distally, finely denticulate.

Synonyms:

Feldestea Iredale, 1955 (*Alvania salebrosa* Frauenfeld, 1867; o.d.).
Nodulestea Iredale, 1955 (*Estea castella* Laseron, 1950, o.d.).

Estea zosterophila zosterophila (Webster). Pl. 17, figs. 1-4; Pl. 18, figs. 1-3.

1898 *Rissoa annulata* Suter (not of Hutton) Proc. Mal. Soc. Lond., 3, p. 3.
1905 *Rissoa zosterophila* Webster, Trans. N.Z. Inst., 37, p. 277, pl. 9, fig. 5.

1913 *Rissoa (Cingula) zosterophila* Webster; Suter, Man. N.Z. Moll., p. 210, pl. 12, figs. 19 a, b.

1915 *Estea zosterophila* (Webster); Iredale, Trans. N.Z. Inst., 4, p. 451.

Estea zosterophila has been much confused in the past because of its variability. There are two specimens labelled holotype and the largest and best preserved is chosen as the lectotype (pl. 18, fig. 1). It is redescribed below to facilitate the recognition of this species.

Shell small, oval, smooth, not shining. No sculpture other than growth lines. Spire very slightly convex; whorls $5\frac{1}{2}$, slightly convex. including a dome-shaped protoconch of $1\frac{3}{4}$ whorls, which is brownish, worn, but minutely pitted spirals visible. Adult whorls dark brown, with a wide whitish subsutural band occupying about a third of penultimate, the lower boundary rather diffuse. This band covers upper half of body whorl, lower half being brownish, becoming yellowish over latter part. Base white, but behind aperture a yellowish-brown band in centre of whorl, which disappears before reaching aperture. Aperture white, except for columella and inner lip which are light yellowish-brown. Base rounded; suture not much impressed. Aperture slightly oblique, oval, weakly angled above; columella short, wide, callous; peristome continuous, much thickened within; outer lip with a sharp edge.

As the type has a dried animal inside it, we can presume that it was alive when collected, but has apparently faded. The protoconch of fresh specimens is dark wine-red and usually the spire is dark reddish-brown. The so-called characteristic colour bands are often absent, some shells being uniform dark brown or red-brown, although these intergrade with typical shells. Paratypes include many of the variations seen in the species, including intergrading series from large to small and dark to banded. A small dark reddish-brown shell (pl. 18, figs. 2 and 3), often called *minor* in collections, is common under stones, usually in exposed situations. This is but another form of *zosterophila*. One sinistrally coiled shell from Spirits Bay is in K. Hipkin's collection. Occasional hybrids with *E. semiplicata* occur. These shells are of similar size to *E. zosterophila*, but have axial ribs on the body whorl and are intermediate in shape between the two species. *E. zosterophila* is characterised by its medium size, its moderately tall spire, small aperture which is not produced beyond the spire, generally dark coloration, and its subsutural white bands. The living New Zealand species most easily confused with *E. zosterophila* is *E. rekohuana*, which is rather larger, more solid and more inflated, with a characteristically larger aperture.

Animal: (Pl. 17, fig. 2). Exposed parts of animal usually peppered with varying amounts of black pigment over head and sides of foot. Cephalic tentacles short, club-shaped, compressed, usually semi-transparent, but sometimes pigmented, ciliated on ventral surface, with some stationary cilia on lateral edges of the distal half; eyes on swellings at outer bases of tentacles. Foot moderately long, sole white, with a mucous slit extending from middle region to posterior end, anterior end bluntly rounded, posterior end slightly notched by mucous slit. Presence of propodium only shown by ill-defined groove on anterior margin of foot. Anterior mucous gland not visible in living animal. Snout expanded in front,

slightly bilobed, a dark line, oral tube usually black. Buccal mass black, visible through head. Two unpigmented streaks passing out of mantle cavity on each side of head, terminate on edge of foot; cilia in both beat ventrally. Penis (pl. 17, fig. 3) coiled, not ciliated, about 2 coils, and lies behind the head affixed to the mid dorsal line.

For other details of the anatomy refer to Ponder, —a.

Operculum: (Pl. 17, fig. 4). Elongate—oval, rather thin, slightly curved in the longitudinal line. Nucleus small, indistinct. Muscle insertion area in columella half, distinct, thickened, marked with short, irregular, longitudinal lines. Marginal areas narrow. Growth lines indistinct.

Radula: (Pl. 17, fig. 1). Central small, with two basal processes, 2 + 1 + 2. Lateral rather small, with a large outer portion, 2 + 1 + 3. Inner and outer marginals elongate, inner broader, with about 12 small denticles, those of outer marginal smaller.

Lectotype: (Pl. 18, fig. 1). Devonport, Auckland (A.M.).
Height 2.15 mm. Width 0.975 mm.

Material Examined:

Holotypes and paratypes; off Motu Point, Cape Maria van Diemen, 21 fathoms, J. A. Bollons, 29/5/14 (D.M.); Cape Maria van Diemen, Finlay Coll. (A.M.); Spirits Bay, shell sand (Hipkins Coll.); Takapau Kura, Spirits Bay, algae, -/2/32 (Powell Coll.); between Cape Maria Island and the mainland, 4 fathoms, -/2/61 (Hipkins Coll.); Parengarenga (Geol. Dept. A.U.); Doubtless Bay, A. E. Brookes (Powell Coll.) and Oliver Coll. (D.M.); Taupo Bay, Whangaroa, W. LaRoche (Powell Coll.) and E. R. Richardson (D.M.); Cavalli Islands, Whangaroa, algae, -/6/52 (D.M.); Waiau Beach, Mangonui, shell sand, E. R. Richardson (D.M.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.); McGregor's Bay, Whangarei Heads, algae, under stones, 22/5/63 (W.F.P.); Smuggler's Bay, Whangarei Heads, *Corallina*, other algae, under stones, -/5/63 (W.F.P.); Taurikura Bay, Whangarei Heads, coralline algae, under stones, -/5/63 (W.F.P.); off Castle Rock, Taurikura Bay, 3-4 fathoms, 7/5/61 (W.F.P.);; 1 fathom, Taurikura Bay, decaying algal detritus (W.F.P.); main channel, Taurikura Bay, on *Glycymeris* valves, 7/5/62 (W.F.P.); Ocean Beach, Whangarei Heads, brown and red algae, 7/5/62 (W.F.P.); Poor Knights Islands, under stones in rock pools, 4/4/64 (W.F.P.); Bream Tail, under stones *Corallina, Carpophyllum*, 12/8/63 (W.F.P.); Laings Beach, Mangawai, shell sand (Hipkins Coll.); Goat Island Beach, Leigh, *Corallina*, various algae, under stones, 1962-64 (W.F.P.); Tawharanui Point, North side, brown algae in rock pools, under stones, 31/12/63 (W.F.P.); Tryphena, Great Barrier Island (Powell Coll. and Hipkins Coll.); Whangaparapara, Great Barrier Island, R. K. Dell, Dell Coll. (D.M.); Shoal Bay, Great Barrier Island, algae (Hipkins Coll.); Okupu, Great Barrier Island, under stones, *Carpophyllum, Corallina*, -/11/63 (W.F.P.); Kaitoke, Great Barrier, coralline algae, *Ulva*, 16/11/63 (W.F.P.); Waiwera, exposed side of reef, coralline algae, 16/2/64 (W.F.P.); Muriwai, coralline algae, under stones (W.F.P.); Manukau Harbour, 4 fathoms, off Wairoa, Waiuku Channel, S. Hulme (W.F.P.); Cornwallis, Manukau Harbour, silted *Corallina*, 7/1/62 (W.F.P.); Matiatia, *Corallina*, 28/12/30 (G.S.); Takapuna, Auckland, under stones (Hipkins Coll.) and under stones, brown algae, *Corallina*, 1962-64 (W.F.P.); Tiritiri Island, *Corallina*, 4/9/31 (C.S.); Motutapu Island, Auckland, under smooth stones (Powell Coll.); Campbell's Bay, Auckland, Laws Coll. (Geol. Dept. A.U.) and *Caulerpa*, W. Ballantine, (W.F.P.); Devonport, Auckland, Webster Coll. (Powell Coll.); Howick, Auckland, *Corallina* (W.F.P.); West Tamaki Heads, Auckland, *Corallina*, -/8/62 (W.F.P.); St. Heliers Bay, Auckland (A.M.); Puru, near Thames, -/8/58 (W.F.P.); Jackson's Bay, Coromandel, fine red algae, 29/3/64 (W.F.P.); Sandy Bay, Coromandel, 30/3/64, *Corallina* (W.F.P.); Stony Bay, Coromandel, coralline and other short algae on stones, 28/3/64 (W.F.P.); Pilot Bay, Tauranga, on stones, A. W. B. Powell, (Powell Coll., G.S., and Geol. Dept. A.U.);

Omokoroa, Tauranga Harbour, 31/8/58 (W.F.P.); Mount Maunganui (G.S.); 46-82 fathoms, N.N.E. of Mayor Island in fish stomach contents, G. Williams (Powell Coll.); Cape Runaway, under stones, -/8/33, A. W. B. Powell (Powell Coll.); Tolaga Bay, shell sand (D.M.); Kaiti Beach, Gisborne, shell sand (D.M.); Tatapouri, Poverty Bay (D.M.); Cape Kidnappers (D.M.); Castle Point, *Corallina*, J. E. Morton (W.F.P.); Island Bay, Wellington, *Corallina*, 21/2/62 (W.F.P.); Lyall Bay, Wellington, Suter Coll. (G.S.) Lyall Bay (D.M.); Owhiro Bay, Wellington, *Corallina*, 20/2/63 (W.F.P.); Makara Beach, M. Mestayer, 26/8/26 (D.M.); Titahi Bay, shell sand (D.M.); Long Beach, Durville Island, rock pools, W. R. B. Oliver (D.M.); *Fossil*: Ohope (Castlecliffian), Laws Coll. (Geol. Dept. A.U.).

Distribution: The East and West coasts of the North Island and the North of the South Island, in the littoral zone and down to a few fathoms.

Ecology: *E. zosterophila*, over most of its range, lives on algae, especially *Corallina*, and under stones. In the southern part of its range, however, this species seems to be restricted to *Corallina*, while *E. rekohuana* lives under stones.

Estea zosterophila ngatutura Laws. Plate 18, fig. 4.

1939 *Estea ngatutura* Laws, Trans. N.Z. Roy. Soc. 68, p. 436, pl. 61, fig. 44.

This subspecies is possibly ancestral to *E. zosterophila zosterophila*, from which it differs in its smaller size, more convex outline, and more deeply impressed suture. The aperture is small as in *E. z. zosterophila*, but rather more D-shaped, the columella being nearly vertical, and the inner lip forming the straight part of the D. The inner lip is more horizontal than in *E. z. zosterophila*.

Holotype: Kaawa Creek (Opoitian (G.S.).

Height 1.5 mm. Width 0.7 mm.

Material Examined: Holotype and paratypes.

Estea asymmetrica Laws. Plate 21, figs. 5, 6.

1941 *Estea asymmetrica* Laws, Trans. Roy. Soc. N.Z., 71, p. 140, pl. 18, fig. 28.

This species is related to the much better known *E. impressa* (Hutton), but differs in the more slender shell and fewer and sharper axials (16 axials on the penultimate whorl against 24 or more in *E. impressa*) which have much wider interstices. There is a spiral rib below the suture, although this is not formed by the top of the axials being cut off by an incised spiral line as in *E. impressa*, but by a true subsutural spiral cord which is visible in the interstices. There is also a supra-sutural spiral cord, which is rather more strongly developed than the subsutural cord on the antepenultimate whorl, but weaker on the body whorl, and forms a spiral cord across the periphery. This is weak in the holotype but strong in the one paratype. These cords are rendered distinctly nodulose by the axials.

Closely comparable to the fossil types are some recent specimens from the North East of the North Island (fig. 6). The main difference is the absence of a peripheral spiral, but a suprasutural spiral is present on the spire whorls. They have similar coloration and 'texture' to *E. impressa* with which they are found, but they are easily distinguished by other characters. There are 15-17 axials on the penultimate whorl of the recent specimens. Their protoconchs are reddish, and the whorls are

sharply angled and sculptured with about six finely granulated spiral lines. Since these specimens agree closely with the fossil types, they are considered to be the same species, despite the absence of interconnecting fossil specimens.

Holotype: (Fig. 5). Pakaurangi Point, Kaipara (Altonian) (G.S.).
Height 1.95 mm. Width 0.875 mm.

Material Examined:

Holotype and one paratype; Waimamaku (Otaian) (Geol. Dep. A.U.). *Recent*: Doubtless Bay, 12 fathoms, Finlay Coll. (A.M.); off Mayor Island, 35-80 fathoms, in stomach contents of Terakiki, G. Williams, (Powell Coll.).

Distribution: Otaian to Recent. Recent distribution in the N.E. of the North Island in moderately deep water.

Estea hipkinsi n. sp. **Plate 21, fig. 9.**

Shell of moderate size for genus, weakly axially costate on last whorl. Spire elongate-conic, about twice height of aperture. Whorls $5\frac{1}{2}$, nearly flat, including protoconch of $1\frac{1}{2}$ whorls, which is dark red in colour, with about 10 lines of granules. Traces of axials on first $2\frac{3}{4}$ whorls but on last $1\frac{1}{4}$ whorls are moderately strong, rounded, nearly vertical axials reaching from suture to suture, extending over base but becoming nearly obsolete on last $\frac{1}{4}$ whorl. About 36 axials on body whorl, interstices narrow. Aperture slightly oblique, oval, angled above, peristome continuous, with a sharp edge, thickened within. Columella short, callous, inner lip thin. Colour of spire reddish owing to colour of internal chitinous shell layer. Worn specimens have a wide, yellowish-white band below suture on spire, but this purplish-grey in holotype. Body whorl and penultimate yellowish with a faint brown band below suture, and two others just below periphery which coalesce a little behind the aperture. Aperture white, columella mostly brown.

Holotype: (Fig. 9). Spirits Bay S.S. Collected R. S. Bird, -/6/51 (Hipkins Coll.) (A.M.).
Height 2.375 mm. Width 1.3 mm.

Material Examined:

Spirits Bay in shell sand, 1949 Collected Mrs I. Worthy (Hipkins Coll.); 4 fathoms between Cape Maria Island and the mainland, -/2/61 (Hipkins Coll.).

Distribution: The far North of the North Island.

The new species differs from *E. impressa* (Hutton) by the absence of a subsutural incised spiral and its larger size. It has some superficial resemblance to *E. semiplicata* Powell which, however, belongs to quite a different group. *E. hipkinsi* differs in having more numerous and weaker axials, and different coloration. *E. manawatawhia* has strong axials over all its whorls. The new species is probably fairly close to certain Australian species but in the absence of comparative material no discussion is possible.

Estea impressa (Hutton). Plate 17, figs. 7-9; Pl. 21, figs. 1-3.

1885 *Rissoa impressa* Hutton, Trans. N.Z. Inst., 17, p. 321.
1893 *Rissoa impressa* Hutton; Hutton, Macleay Mem. Vol., Pliocene Moll., p. 64, pl. 8, fig. 64.

1905 *Rissoina agrestis* Webster, Trans. N.Z. Inst., 37, (1904 (1905)), p. 279, pl. 10, fig. 10.
1907 *Rissoa impressa* Hutton; Suter, Trans. N.Z. Inst., 39, p. 257.
1913 *Rissoa (Rissoa) impressa,* Hutton; Suter, Man. N.Z. Moll., p. 201, pl. 12, fig. 3.
1915 *Rissoa impressa,* Hutton; Suter, Geol. Surv. Bull., 3 p.4.
1915 *Estea impressa* (Hutton); Iredale, Trans. N.Z. Inst., 47, p. 454.
1924 *Haurakia mixta* Finlay, Trans. N.Z. Inst., 55, p. 482, fig. 1.
1924 *Estea impressa* (Hutton); Finlay, Trans. N.Z. Inst., 55, p. 487.
1929 *Estea verticosta* Powell and Bartrum, Trans. N.Z. Inst., 60, p. 415, pl. 37, figs. 25, 26.

Much variation is seen in this species; size, relative width, number and degree of slope of the axial ribs, and strength of the subsutural cord, being the most variable features. Fossil specimens (including the types), are on the average, larger than recent shells, though this is not always the case. In many northern localities large and small specimens are found living together (figs. 2 and 3), but there are no differences between them other than size.

The shell is easily recognised by its small size, rather convex spire, numerous axial ribs (20-25 on the penultimate) extending over all the adult whorls, and the incised spiral line below the suture forming a row of nodules on the ribs between the line and the suture. The colour is distinctive, being pinkish to red, with the body whorl yellowish or white. The protoconch is red, and sculptured with fine, spiral, granulated lines, and its whorls are convex to sharply angled. *E. olivacea* Frauenfeld (pl. 21, fig. 4) differs from *E. impressa* mainly in minor details of colour and sculpture. The Australian shells are uniform yellowish brown and the spire whorls tend to develop only subobsolete axials. *E. verticosta* Powell and Bartrum comes well within the range of variation of *E. impressa.* The authors state that the suture is not margined, but this is not the case in the holotype and the one paratype.

Iredale (1955) has provided a genus *Nodulestea* for *Estea castella* Laseron. This species is, in fact, very closely related to *E. olivacea* and *E. impressa,* the main difference being that instead of one row of nodules there are three, which extend over the whole whorl surface. They are formed in the same manner as the single, spiral, nodulose cord of *E. olivacea,* i.e. by incised spiral lines cutting the strong axial sculpture. Since *E. impressa* and *E. olivacea* are clearly typical *Estea,* to separate *E. castella,* even at the subgeneric level, would be a most undesirable move. Thus *Nodulestea* Iredale, 1955, is a synonym of *Estea* Iredale, 1915.

Animal: External coloration white, snout slightly bilobed, tentacles short, club-shaped, ventral surface with active cilia, distal half of tentacles with long immobile cilia; eyes rather large, in swellings at outer bases of tentacles. Foot rather long, anterior end bluntly rounded, with long, posteriorly lashing, cilia just behind anterior edge on sole. Rest of sole with posteriorly directed cilia, posterior end rounded, mucous slit extending from middle region to posterior end. Penis (pl. 17, fig. 8) long and narrow, pointed, about 2 coils, attached to mid-line.

Operculum: (Pl. 17, fig. 9). Oval broader than *E. zosterophila,* muscle insertion area not distinct, marginal areas narrow. Faint spirals and growth lines are only sculpture.

Radula: (Pl. 17, fig. 7). Central with two long, oblique, latero-basal processes, and two short basal projections, cusps 1 + 1 + 1. Lateral with long outer portion, cusps 2 + 1 + 2. Inner marginal with about 12 fine denticles. Outer marginal apparently smooth.

Lectotype: (Fig. 1). (Chosen by H. Suter) Petane (Nukumaruan) (Cant. Mus.).

Height 2.275 mm. Width 1.05 mm.

Material Examined: Fossil—

Lectotype and paralectotype; Pohangina (Duntroonian) Laws Coll. (Geol. Dept. A.U.); Matiatia, Waiheke Island (Altonian) (holotype and paratype of *E. vertiscosta*) (A.M.); Kaawa Creek, (Opoitian) Laws Coll. (Geol. Dept. A.U.); Wilkies Bluff (Waitotaran), Laws Coll. (Geol. Dept. A.U.); Nukumaru (Nukumaruan or Hautawan), Laws Coll. (Geol. Dept. A.U.); Nukumaru Brown Sands (Nukumaruan) (G.S. and Powell Coll.); Tahoraite, S.E. 120 chains at 160° to trig A.W., Hawke's Bay (Nukumarian) (G.S.); Takapau S.D., N.E. (Nukumaruan) (G.S.); Hunterville, Turakino, Valley Road, (Nukumaruan) (G.S.); Castlecliff (Castlecliffian) Laws Coll. (Geol. Dept. A.U. and G.S.); Castlecliff 'B' (Castlecliffian) (G.S.); Ohope (Castlecliffian) Laws Coll. (Geol. Dept. A.U.); Waikopiro, Wanganui (Castlecliffian?) (locality uncertain) (G.S.); Motunau Raised Beach (Hawera series) (upper Pleistocene) (G.S.). *Recent*: N.Z.O.I. Stat. C. 760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.); 4 fathoms, between Cape Maria Island and mainland (Hipkins Coll.); Cape Maria van Diemen, Suter Coll. (G.S.); Cape Maria van Diemen, Dell Coll. (D.M.); Kapo Wairoa, Spirits Bay (Powell Coll.); Spirits Bay, shell sand (Hipkins Coll.) and 29/12/50 (Gardner Coll.); Waiau Beach, Mangonui, E. R. Richardson, 11/12/50 (D.M.); Doubtless Bay, 12 fathoms, Finlay Coll. (A.M.); Taupo Bay, Whangaroa, 2/1/54 (Hipkins Coll.); E. R. Richardson, 11/4/51 (D.M. and G.S.); Tapeka Point, Russell, R. K. Dell, 28/11/50 (D.M.) and -/1/52 (Hipkins Coll.); Taurikura Bay, Whangarei Heads, 1 fathom, -/5/63 (W.F.P.); Taurikura Bay, under stones, coralline algae, -/5/63 (W.F.P.); off Castle Rock, Taurikura Bay, 3-4 fathoms and in the main channel, in *Glycymeris-Tawera* community -/5/62 (W.F.P.); Smuggler's Bay, Whangarei Heads, under stones, low tide, -/5/63 (W.F.P.); Ocean Beach, Whangarei Heads, *Carpophyllum plumosum*, 7/5/62 (W.F.P.); dredged off Mokohinau Islands (W.F.P.); Poor Knights Islands, under stones in rock pools at low tide, 29/3/64 (W.F.P.); 22 fathoms, off the Hen and Chickens Islands, Finlay Coll. (A.M.); Near Little Barrier, 20 fathoms, Suter Coll. (G.S.); Tryphena, Great Barrier Island, Finlay Coll. (A.M.) (and G.S.) Shoal Bay, Great Barrier, algae washings (Hipkins Coll.); Whangaparapara, Great Barrier Island, R. K. Dell, Dell. Coll. (D.M.); Okupu, Great Barrier Island, under stones and in *Corallina*, 24/11/63 (W.F.P.); Bream Tail, under stones, 12/8/63 (W.F.P.); Goat Island Bay, Leigh, under stones 1/1/64 (W.F.P.); Tiri Tiri Island (G.S.); Tawharanui Point, North side, under stones on papa platform (W.F.P.); Waiwera, on exposed side of reef, *Corallina*, 16/2/64 (W.F.P.); Motuihe Channel, off Emu Rock, 8 fathoms, *Tawera-Glycymeris* community, 15/5/63 (W.F.P.); Channel Island, Suter Coll. (G.S.); West Tamaki Heads, Auckland, coralline algae on rock platform, under stones in pools, (W.F.P.); Takapuna, Auckland, Suter Coll. (G.S.); Takapuna and Narrow Neck, Auckland, under stones, *Corallina*, 1962-64 (W.F.P.); St. Heliers Bay, Auckland, Finlay Coll. (A.M.); 10 fathoms off Kauri Point, Auckland Harbour (Powell Coll.); Kohimarama (G.S.); Jackson's Bay, Coromandel, under stones, 29/3/64, (W.F.P.); Stony Bay, Coromandel, *Corallina*, other short algae, under stones, 28/3/64 (W.F.P.); 96 fathoms, 1½ miles N.N.E. off Mayor Island, S. M. Hovell (Powell Coll.); Mayor Island, 35-80 fathoms, G. Williams (Powell Coll.); Cape Runaway, under stones, A. W. B. Powell (Powell Coll.); Tolaga Bay, R. K. Dell, 28/11/50 (D.M.); Island Bay, Wellington, shell sand, 2/10/56 (W.F.P.); Eastbourne, Wellington, (W.F.P.); B.S. 101, off White Rocks, Queen Charlotte Sound, 25 fathoms, (D.M.); B.S. 129, Pelorus Sound, 25-30 fathoms, M.V. "Alert", (D.M.); Pile Bay, Lyttelton Harbour, Dell. Coll. (D.M.); East of Diamond Harbour, Lyttelton Harbour, *Corallina*, under stones, -/9/63 (W.F.P.); Waitangi, shell sand (G.S.); Chatham Island Exped. Stat. 38, South of Little

Mangere, 43 fathoms, M.V. "Alert", 2/2/54 (D.M.); 10 fathoms, off Owenga, Chatham Islands, A. W. B. Powell, -/8/33 (A.M.).

Distribution: Duntroonian to Recent. The recent geographical distribution is the North Island East Coast, the Marlborough Sounds and the East Coast of the South Island, at least as far south as Banks Peninsula. I have not seen *E. impressa* from the West Coasts of either Island. It also occurs at the Chatham Islands. Typically living under stones in the littoral zone, it may also occur on coralline and other algae. The depth range is not great, for sublittorally this species seems to be restricted to hard bottoms such as those occurring in tidal channels.

Estea insulana insulana Marwick. **Plate 19, fig. 1.**

1928 *Estea insulana* Marwick Trans. N.Z. Inst. 58. p. 478, fig. 115.

This fossil is very similar to the recent *E. porrecta* Powell which is best considered to be subspecific. The surface is smooth and shining, with faint growth lines. The paratypes are all very like the type, but one is a little more slender (2.7 x 1.15 mm.). The fossil subspecies differs from the recent form by its slightly shorter spire. Powell (1933, p. 201) and Dell (1960, p. 146) record "cf. *insulana*" from the Chathams as a recent shell. However, it seems that all the recent material should be referred to *porrecta*, because, on the average, the recent shells are taller, and no distinct line exists between the short and tall spired forms.

Holotype: (Fig. 1). Titirangi, Chatham Island (Nukumaruan) (G.S.).
Height 2.4 mm. Width 1 mm.

Material Examined: Holotype and paratypes.

Distribution: Nukumaruan, middle Pleistocene.

Estea insulana porrecta Powell. Plate 19, figs. 2-4.

1928 *Estea* c.f. *subfusca* (Hutton); Finlay, Trans. N.Z. Inst., 59, p. 242.
1933 *Estea porrecta* Powell, Rec. Auckland Inst. Mus., 1 (4), p. 201, pl. 35, fig. 8.
1933 *Estea* c.f. *insulana* Marwick; Powell, Rec. Auck. Inst. Mus., 1 (4), p. 201.
1960 *Estea porrecta* Powell; Dell, D.S.I.R. Bull., 139 (4), p. 146.
1960 *Estea* c.f. *insulana* Marwick; Dell, D.S.I.R. Bull., 139 (4), p. 146.

This shell is distinguished by the very tall spire, smooth surface, slightly convex whorls, medium size and oval aperture.

The type of *porrecta* is a tall, beach worn shell. The colour of fresher specimens (Chatham Islands Exp. Stn. 38) is reddish-purple, with the last half of the body whorl and the protoconch, yellowish. The height of the spire varies in recent specimens (c.f. figs. 2 and 4), and the shorter spired forms (fig. 2) are very close to *insulana insulana*.

Holotype: (Fig. 3). Waitangi, Chatham Islands, -/2/33 (A.M.).
Height 2.575 mm. Width 0.95 mm.

Material Examined:

Holotype; Chatham Islands Exped. Stn. 38, South of Little Mangere in 43 fathoms, M.V. "Alert", 2/5/54 (D.M.); Chatham Island Exped. Stat. 20, 43° 39' S., 176° 34.5' W., off Cape Young, 20 fathoms, M.V. "Alert", 28/1/54 (D.M.); Chatham Islands Exped. Stat. 23, 43° 32.5' S., 176° 47.5' E., North of the Sisters, 33 fathoms, 29/1/54, M.V. "Alert" (D.M.); off Owenga, Chatham Islands, 10 fathoms, A. W. B. Powell (A.M.).

Distribution: The Chatham Islands in moderately deep water.

Estea insulana porrectoides Powell. **Plate 19, figs. 6-8.**

1937 *Estea porrectoides* Powell, Disc. Rep., 15, p. 197, pl. 53, fig. 1.

The convex spire, flattened whorls and small thickened aperture make this form rather distinctive, though it is closely related to *insulana* and should be considered as subspecific, as it has a distinct geographical distribution. The paratypes are dead shells and most of them are rather worn, though in the best preserved specimens fine oblique axial growth striae are visible on the body whorl. The colour of the protoconch is yellowish, and the spire dark reddish-brown to yellow, usually with a paler (often white) subsutural band. The body whorl is lighter in colour, and the columella brown.

There is a shallow water form of this subspecies which is similar in outline and apertural details. It differs in being smaller in size with a relatively shorter spire, and much stronger axial striae, which are often developed over the entire shell. Sometimes a dark colour band is developed on the periphery (fig. 8).

Two shells from Discovery II Station 929 (fig. 7) are very close to *E. insulana porrecta* Powell in shape, as they have rather convex whorls. However they probably represent a form of *porrectoides.*

Holotype: Off the Three Kings Islands, Discovery II Station 933, in 260 metres (Brit. Mus.).

Height 2.55 mm. Width 1.1 mm. (from Powell)

Material Examined:

Paratypes (Powell Coll.); Discovery II Station 929 off Spirits Bay, 59 metres (Powell Coll.); 50 fathoms, between Cape Maria van Diemen and the Three Kings Islands, 1961 (Hipkins Coll.); 4 fathoms, between Cape Maria Island and mainland, -/2/61 (Hipkins Coll.); Cape Maria van Diemen, Dell Coll. (D.M.); Spirits Bay, shell sand (Hipkins Coll.); 4½ fathoms, off Reach Island, Whangaroa (W.F.P.); 22 fathoms, ½ mile south of Stephenson's Island, 3½ miles from Whangaroa, 29/12/53 (Hipkins Coll.); Whangaroa Heads, Dell Coll. (D.M.); 38 fathoms off Cuvier Island, Finlay Coll. (A.M.); 18 fathoms off Taranga (Hen) Island (G.S.); 45 fathoms, 1 mile off East side of Mayor Island in Terekiki stomach contents, G. Williams, 3/12/49 (Powell Coll.); 35 fathoms, Tuhua Reef, Mayor Island, fish stomach contents, G. Williams (Powell Coll.).

Distribution: The North East coast of the North Island North of East Cape, usually in fairly deep water.

Estea koruahina Laws. **Plate 21, fig. 11.**

1939 *Estea koruahina* Laws, Trans, Roy. Soc. N.Z., 68, p. 436, pl. 61, fig. 37.

All the specimens which have been seen of this species are very badly erroded or immature. The holotype is an adult shell and the outline of fig. 11 is taken from it, but details of the sculpture are derived from that remaining on the holotype and three paratypes. The juvenile paratypes are better preserved and in them the spire appears to be smooth, but the last third of the penultimate whorl and the first two-thirds of the body whorl have rounded axials and 4 spiral cords. The axials terminate on the third spiral, and both the third and fourth are smooth and rather weak. The first is subsutural and rendered faintly nodulous by the axials, and the second is wide, but indistinct, slightly nodulous and a little below the middle of the whorl. The base is distinctive in having a well-developed fold supporting the columella which is separated

from the rest of the base by a weak groove. Most species of *Estea* have this fold weakly developed, owing to a tendency of the aperture to uncoil slightly, but it is relatively massive in *koruahina*.

This species is possibly related to *E. semiplicata* Powell, but seems to be even closer to *E. rugosa* (Hutton).

Holotype: Kaawa Creek, Auckland (Opoitian lower Pliocene) (G.S.).
Height 2.8 mm. Width 1.45 mm.

Material Examined: Holotype and paratypes; Kaawa Creek (Opoitian) (Geol. Dept. A.U.).

Distribution: Opoitian.

Estea manawatawhia Powell. Plate 21, fig. 7.

1937 *Estea manawatawhia* Powell, Disc. Rep. 15, p. 198, pl. 53, fig. 3.

E. manawatawhia is unlike any other New Zealand species, with its heavy axial ribs extending on to the base (about 16 on the penultimate), and brown and white colour bands. There appears to be very little variation. Animal unknown.

Holotype: Discovery II Station 932, off the Three Kings Islands, 185 metres, (Brit. Mus.).
Height 2.7 mm. Width 1.4 mm. (from Powell)

Material Examined:

Paratypes; (Powell Coll.); N.Z.O.I. Stat. C. 760, 34° 10.8' S., 172° 8.4' E., off Three Kings Islands, 44 fathoms, bryozoan substrate, 18/2/62 (O.I.).

Distribution: Off the Three Kings Islands in moderately deep water.

Estea micronema micronema (Suter). Plate 19, figs. 12-14.

1873 *Rissoa purpurea* Hutton, Cat. Mar. Moll. N.Z. p. 29, (not *R. purpurea* Jeffreys, 1841).
1898 *Rissoa subfusca micronema* Suter, Proc. Mal. Soc. Lond., 3, p. 4.
1909 *Rissoa* (*Cingula*) *subfusca micronema* Suter; Suter, Subantarctic Islands, N.Z. 1, p. 17.
1913 *Rissoa* (*Cingula*) *subfusca* Hutton; Suter, (in part), Man. N.Z. Moll. p. 210.
1913 *Rissoa* (*Cingula*) *subfusca micronema* Suter; Suter, Man. N.Z. Moll. p. 210.
1915 *Estea subfusca* var. *micronema* (Suter); Iredale, Trans. N.Z. Inst., 47, p. 454.
1928 *Estea subtilicosta* Marwick, Trans. N.Z. Inst., 58, p. 478, fig. 116.
1955 *Estea micronema* Suter; Powell, D.S.I.R. Cape Exped. Series, Bull., 15, p. 83.
1956 *Estea sculpturata* Dell, Dom. Mus. Bull., 18, p. 62, fig. 18.

This distinctive species has not previously been figured under its correct name. It is easily distinguished by its cylindrical, slightly convex spire, reticulate sculpture and circular often projecting, aperture. The first half of the first adult whorl in the lectotype is nearly smooth with only a few indistinct axials, but many specimens have the typical adult sculpture extending nearly to the protoconch. In the type specimen there are about 15 spirals on the penultimate whorl, and these cross rather irregular axials, rendering them weakly nodulous. The whole effect is to give a crisply nodulous appearance to the surface. The whorls are very lightly convex but in some specimens, including the type, the penultimate is slightly angled and cut into the suture in its lower quarter, but this is not always the case. The protoconch is typical for

the genus. Fresh shells are purplish-red on the spire while the body whorl and aperture are yellowish-white or white. Specimens from some localities (e.g. the Snares Islands) reach a larger size than the type and have more spirals per whorl, but are otherwise indistinguishable from it. *E. sculpturata* Dell (fig. 13), from off the East Otago Coast in 300 fathoms, is identical with *E. micronema,* while *E. subtilicosta* Marwick (fig. 14), a fossil from the Chatham Islands, is very close indeed to recent shells and should be considered conspecific. The fossil shells do not show any spiral sculpture, but neither do worn recent shells.

Lectotype: (Fig. 12). Stewart Island, 15 fathoms (G.S.).
Height 2.825 mm. Width 1.15 mm.

Material Examined:

Lectotype and paralectotypes; 40 and 72 fathoms, off Otago Heads, Laws Coll. (Geol. Dept. A.U.); 60 fathoms, off Otago Heads, Finlay Coll. (A.M.); B.S. 190, off East Otago Coast, 300 fathoms (D.M.) (holotype and paratypes of *E.sculpturata*); 72 fathoms, off Cape Saunders, Otago, Laws Coll. (Geol. Dept. A.U.); Bluff, Finlay Coll. (A.M.); Foveaux Strait oyster beds, (D.M.); Fish Rocks, Foveaux Strait, 30 fathoms, O. Allan, -/6/51 (D.M.); Foveaux Strait, 15 fathoms, A. Hamilton (Powell Coll.); middle grounds, Foveaux Strait, 30 fathoms, O. Allan, -/6/51 (D.M.); Stewart Island, 15 fathoms, H. Suter (D.M.); 170 fathoms off Puysegur Point S.W. Otago (Powell Coll.); B.S. 106, between Unnamed Island and Breaksea, Dusky Sound, 20 fathoms, M.V. "Alert", 7/5/58 (D.M.); B.S. 104, Chalky Inlet, 20 fathoms M.V. "Alert", W. H. Dawbin, 6/5/50 (D.M.); 50 fathoms, Snares Islands, Finlay Coll. (A.M.) and Suter Coll. (G.S.). *Fossil*: Titirangi, Chatham Island (Nukumaruan) (holotype and paratypes of *E. subtilicosta*).

Distribution: Moderately deep, to deep water, in the South of the South Island, Stewart Island and the Snares.

Fossil Distribution: Nukumaruan, lower Pleistocene.

Remarks: The Australian *E. amblycorymba* Cotton (1944), has similar sculpture.

Estea micronema morioria Powell. **Plate 19, figs. 15, 15a.**

1933 *Estea morioria* Powell, Rec. Auck. Inst. Mus. 1 (4), p. 200, pl. 35, fig. 6.

This subspecies is about half the size of *micronema micronema*, but is a similar shape and has the same sculpture. The holotype consists of two fragmentary specimens, one having only a body-whorl and the other with the aperture missing. The sculpture is of coarse, close, axial growth lines, which are slightly nodulated by weaker spirals placed at fairly wide intervals (about 20 on the BW.) giving a rugose appearance to the shell. The protoconch is dome-shaped, and is sculptured with about 16 rows of dots. The dead shells are brown in colour, with a narrow whitish subsutural band. There is a pale smooth line running across the periphery which is weakly subangled.

E. m. morioria is slightly more conical in outline than *E. m. micronema,* and has much finer sculpture (but this is due to its smaller size), and a more coarsely striated protoconch. The outer-lip has no posterior sinus, whereas it is weakly developed in *E. m. micronema.*

Holotype: (Figs. 15, 15a). 10 fathoms, off Owenga Beach (A.M.).
Height 1.9 mm. (estimated) Width 0.7 mm. (estimated)

Material Examined: Holotype.

Distribution: Chatham Islands.

Estea minor (Suter). Plate 18, figs. 5, 6.

1898 *Rissoa annulata* var. minor Suter, Proc. Malac. Soc. Lond. 3, p. 3.
1913 *Rissoa* (*Cingula*) *zosterophila* var. *minor* Suter; Suter, Man. N.Z. Moll., p. 211.
1915 *Estea zosterophila* var. *minor* (Suter); Iredale, Trans. N.Z. Inst., 47, p. 454.
1933 *Estea minor* Powell, Rec. Auck. Inst. Mus. 1 (4), p. 200, p. 135, fig. 4, (lectotype).
1934 *Amphithalamus* (*Pisinna*) *kohl-larseni* L. David; Senckenbergiana 16, Nos. 2-3, p. 133, fig. 4.
1955 *Estea minor* Powell, D.S.I.R. Cape Exped. Series Bull., 15, p. 83.

Minute size, dark coloration, smooth, shining surface and bulging middle whorls are the keynotes of this species. The lectotype has an orange-red spire, but the body whorl is lighter in colour, the aperture yellowish, and there is a faint yellowish band beneath the suture. The protoconch is deep reddish and minutely pitted. This coloration is unusual and possibly due to these specimens (the types) being from deep water (type locality Foveaux Strait). Specimens from the littoral zone are dark reddish brown to dark chocolate, with the body whorl slightly paler. There is never any sculpture, the surface being smooth and shining, with very faint growth lines only. The only variation is in relative width (cf. figs. 5 and 6).

Lectotype: (Fig. 5). Foveaux Strait (G.S.).
Height 1.55 mm. Width 0.7 mm.

Animal: (Portobello). Semi-transparent—white externally, with a moderately long snout, fairly long tentacles with swollen ends, but flattened dorso-ventrally, ciliated on the ventral side and with motionless setae on the distal half.

Material Examined:

Lectotype and paralectotypes; Bushey Beach, Oamaru, W. Ballantine, 24/2/64 (W.F.P.); Portobello, Dunedin Harbour, in coralline algae, 3/9/63 (W.F.P.); Ships' Channel side of Quarantine Island, Dunedin Harbour, in coralline algae, 4/9/63 (W.F.P.); Taieri Beach, Finlay Coll. (A.M.); Middle Grounds, Foveaux Strait, 15-30 fathoms, -/6/51, O. Allan (D.M.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.); Mason's Bay, Stewart Island, R. H. Harrison (A.M.) and O. Allan, -/8/48 (D.M.); Doubtful Sound in 50 fathoms (W.F.P.); B.S. 185, Casewell Sound, 10 fathoms, R. K. Dell, 23/3/49 (D.M.); Faith Harbour, Auckland Islands (Powell Coll.); Ewing Island, Port Ross, Auckland Islands, Cape Expedition (A.M.); Waitangi, Chatham Islands, shell sand (Powell Coll.); Waitangi, algae between tides, W. R. B. Oliver, -/12/09 (D.M.); Chatham Island Exped. Stat. 38, 43 fathoms South of Little Mangere, 2/2/54 M.V. "Alert" (D.M.); Chatham Islands Exped. Stat. 16, Kaingaroa, shell sand, 27/1/54 (D.M.); in shell sand, Port Hutt, Chatham Islands, 8/2/54 (D.M.); Chatham Islands Exped. Stn. 2, 42° 59.4' S., 175° 304' E., Mernoo Bank, 61 fathoms, 23/1/54 (D.M.). *Subfossils* Motunau Raised Beach, Hawera series (Upper Pleistocene) (G.S.).

Distribution: The far South of the South Island, Auckland Islands and Chatham Islands in the littoral zone and deep water.

Estea aff. minor (Suter). Plate 18, fig. 7.

A single specimen related to *minor* (Suter) from Waimumu has a taller spire than recent specimens (1.9 x 0.775 mm.).

Material Examined: Waimumu S.D. (Duntroonian-Waitakian) (G.S.).

Remarks: The antiquity of this specimen, together with the differences in shell characters, suggest this is a subspecific forerunner of *minor*. However insufficient material is available for a name to be applied. *E. minor* is not recorded as a fossil, and no related species connect these two forms.

Estea missile Laws. Plate 19, fig. 5.

1940 *Estea missile* Laws, Trans. Roy. Soc. N.Z., 70, p. 50, pl. 5, fig. 11.

This rather small shell is a very distinctive species with its rather tall spire, which has a slightly convex outline and moderately expanded aperture. Most distinctive of all, it is smooth with a prominent suprasutural channel developed on the adult whorls and, weakly, across the periphery. It is not closely related to any other species.

Holotype: (Fig. 5). Mangapani, Taranaki (Upper Waitotaran) (G.S.).

Height 2.025 mm. Width 0.9 mm.

Material Examined: Holotype and two paratypes; Nukumaru Brown Sands, (Nukumaruan) (G.S. and Geol. Dept. A.U.) Ohope, (Castlecliffian) Laws Col. (Geol. Dept. A.U.).

Distribution: Upper Waitotaran Pliocene to Castlecliffian, Pleistocene.

Estea polysulcata Finlay. Plate 20, fig. 5.

1924 *Estea polysulcata* Finlay, Trans. N.Z. Inst. 55, pp. 486-487, fig. 8.

This is a little-known species very close to *E. rugosa* (Hutton) and *E. semisulcata* (Hutton), but differing in having more numerous spiral cords. All specimens seen were in poor condition, but there seemed to be no axial sculpture developed. The holotype has 9 strong, unequally developed, spirals on the body whorl above the periphery, and 5 faint spirals on the base. The interstices are generally narrow, and the spiral cords low. The spire whorls have about 6 faint spirals in other specimens examined (the holotype has the spire badly worn). The spire is rather tall with slightly convex outlines, and the whorls are faintly convex and cut in below at the sutures. The aperture was not fully developed in any specimens examined. The holotype is immature with the inner lip a thin glaze only, and the outer lip thin and sharp.

Holotype: (Fig. 5). Maraekakaho Creek (3 miles above junction with Ngaruroro River, Geol. Surv. loc. 1102), (Nukumaruan) (G.S.).

Height 3.6 mm. (estimated) Width 1.6 mm. (estimated)

Paratype: (Not examined) Nukumaru.

Material Examined: Holotype; Hunterville, Turakino Road (Nukumaruan) (G.S.).

Distribution: Nukumaruan, lower Pleistocene.

Estea praecidecosta n. sp. Plate 21, fig. 8.

Shell large for genus, axially ribbed, solid, ovate-conical, outlines of spire very lightly convex, brown. Whorls $5\frac{3}{4}$, very lightly convex, cut

in at sutures; protoconch $1\frac{3}{4}$ whorls, dome-shaped, very finely sculptured with minute punctures in numerous spiral series, terminated by weak varix. Sculpture of straight or slightly oblique strong axials, about 22 on penultimate. A faint spiral subsutural and suprasutural swelling, but no true cord. An incised spiral line on periphery of body whorl abruptly terminates axials. Axials obsolete over last quarter of body whorl. Base with fine axial ribs crossed by weak spiral scratches. Apertural oval, small; columella thick, separated from base, white. Inner lip wide, outer lip with a wide, shallow, anterior sinus, thickened above, rather thin below, sharp edged, white. Colour uniform brown. The axials vary in strength, sometimes becoming almost obsolete. Differs from *E. manawatawhia* in size, number of axials, colour, and the termination of the axials at the periphery. Animal unknown.

Holotype: (Fig. 8). N.Z.O.I. Stat. C. 760, off Three Kings Islands, 34° 10.8' S., 172° 8.4' E., 44 fathoms, bryozoan substrate, 18/2/62 (O.I.).

Height 3.7 mm. Width 1.775 mm.

Paratypes: New Zealand Oceanographic Institute, Auckland and Dominion Museums.

Material Examined:

Holotype and paratypes; Discovery II Stat. 932, off Three Kings Islands, 185 metres (among paratypes of *E. manawatawhia*) (Powell Coll.); Discovery II Stat. 92, 59 metres, off Spirits Bay (Powell Coll.); 50 fathoms, between Cape Maria van Diemen and Three Kings Island, 1961 (Hipkins Coll.).

Estea rekohuana rekohuana Powell. Plate 18, figs. 8-10.

1924 *Rissoa subfusca* Odhner (not of Hutton), N.Z. Moll. Pap. Mortensen Pacific Exped. p. 22.
1928 *Estea* n. sp. aff. *minor* Finlay, Trans. N.Z. Inst., 59, p. 242.
1933 *Estea rekohuana* Powell, Rec. Auck. Inst. Mus. 1 (4), p. 199, pl. 35, fig. 9.
1955 *Estea rekohuana* Powell; Powell, D.S.I.R. Cape Exped. Series, Bull., 15, p. 84.

Though rather similar to *E. zosterophila*, *E. rekohuana* is easily distinguished by its larger and heavier shell. The colour and adult size tend to be fairly variable. Specimens collected alive from the type locality (Waitangi, Chatham Islands) and agreeing closely with the type, have the spire varying from dark reddish- or purplish-brown to dark yellowish-brown, often with a whitish subsutural band which is variable in width. The aperture is pale yellowish-brown, except for a brown blotch on the columella, and the base may be the same colour as the spire, or paler. The protoconch is dark red in colour and sculptured with many minutely punctuate, fine, spiral lines. Stewart Island specimens (fig. 10) are often taller and larger than shells from other localities, pinker in colour, and with more obvious white bands, but these differences are by no means constant. Shells from the Auckland and Antipodes Islands (fig. 9) are often broader than the majority of specimens examined, but again, this is not a constant feature. Shells from most other localities agree well with the type series. However, at the northern end of the range of this subspecies (Cape Runaway), are found more elongate, dark reddish shells, with a yellowish-brown body whorl, white aperture, and faint subsutural pale bands. They are close to a yet taller form found North of East Cape, which is separated as a subspecies. The holotype (fig. 8) is slightly distorted owing to fractures

on the third and fourth whorls which have caused a narrow step below the suture on the third whorl, and make the shell a little lopsided.

Animal: (Portobello, Dunedin). General colour externally dark grey owing to black pigment cells scattered over surface, but ground colour white. Sole dense white and opercular lobes dark grey. Tentacles club-shaped, compressed, transparent with a 'dusting' of black pigment on anterior and posterior edges, with active cilia on ventral edge, longer immobile cilia terminally.

Holotype: (Fig. 8). Waitangi, under stones, A. W. B. Powell, -/2/33 (A.M.).

Height 2.0 mm. Width 1.875 mm.

Material Examined:

Holotype and paratypes; Cape Runaway, under stones, A. W. B. Powell, -/8/33 (Powell Coll.); Tolaga Bay, R. K. Dell (D.M.); Wainui Beach, Gisborne, Laws Coll. (Geol. Dept. A.U.); Gisborne, shell sand, 1906 (D.M.); Kaiti Beach, Gisborne, R. K. Dell, 26/11/50 (D.M.); Island Bay, Wellington, under stones, A. W. B. Powell (Powell Coll.) and shell sand, 2/10/56 (W.F.P.); Lyall Bay, Wellington, Finlay Coll. (A.M.); Lyall Bay, shell sand (W.F.P. and D.M.); Point Howard, Wellington Harbour (W.F.P.); Seatoun, Wellington, R. K. Dell (D.M.); Makara Beach, M. Mestayer, 26/8/26 (D.M.); Titahi Bay (D.M., G.S. and W.F.P.); Paremata Harbour (W.F.P.); Cape Campbell, *Corallina,* 16/2/64, W. Ballantine (W.F.P.); Mudstone Bay, Kaikoura, *Corallina,* R. A. Rusmussen, 12/6/64 (W.F.P.); Shark's Tooth Reef, Kaikoura, under stones, P. Luckens, 12/8/64 (W.F.P.); Oaro, South of Kaikoura, coralline algae, W. Ballantine, 19/2/64, (W.F.P.); Lyttelton and Te Onepoto, Suter Coll. (G.S.); Akaroa, Laws Coll. (Geol. Dept. A.U.); Wainui, Akaroa, under stones, A. W. B. Powell (Powell Coll.); East of Diamond Harbour, Lyttelton Harbour, *Corallina,* under stones, -/8/63 (W.F.P.); Pile Bay, Lyttelton Harbour, Dell Coll. (D.M.); Purau, Lyttelton Harbour, shell sand, W. R. B. Oliver, 1/1/07 (D.M.); Taylor's Mistake, Bank's Peninsula, soft coralline algae in rock pools, W. R. B. Oliver, 10/4/10 (D.M.); Timaru, W. R. B. Oliver, -/2/07 (D.M.); Bushey Beach, Oamaru, coralline algae, W. Ballantine, 24/1/64 (W.F.P.); Moeraki, Finlay Coll. (A.M.); Warrington, Dunedin, Laws Coll. (Geol. Dept. A.U.); Dunedin Harbour, 3 fathoms (Powell Coll.); Portobello, Dunedin Harbour, Finlay Coll. (A.M.) and *Corallina,* under stones, 3/9/63 (W.F.P.); off Wharf, Portobello, 2-3 fathoms, 3/9/63 (W.F.P.); Little Papanui, Dunedin, under stones in contact with sand, 3/9/63 (W.F.P.); Taieri Beach, Finlay Coll. (A.M.); Bluff Harbour, in *Corallina,* M. Spong, 27/5/63 (W.F.P.); Halfmoon Bay, Stewart Island, E. Smith (Powell Coll.), under stones, R. K. Dell, 30/10/48 (D.M.) and under stones, M. Spong, -/3/63 (W.F.P.); Aker's Point, Halfmoon Bay, under stones, M. Spong, 22/2/63 (W.F.P.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.); Mason's Bay, Stewart Island, O. Allan, -/8/48 (D.M.); Ulva Island, Paterson Inlet, O. Allan, 1949 (D.M.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", W. H. Dawbin, 6/5/50 (D.M.); B.S. 137, off Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin, 8/1/52 (D.M.); B.S. 107, Gaol Passage, Doubtful Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 8/5/50 (D.M.); B.S. 185, Casewell Sound, 10 fathoms, R. K. Dell, M.V. "Alert" (D.M.); B.S. 110, inside entrance to George Sound, 15-20 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.); Snares Islands, 50 fathoms, Finlay Coll. (dead shells) (A.M.); Carnley Harbour, Auckland Islands, 6 fathoms (G.S.) and J. Sorensen, -/4/47 (D.M.); Auckland Islands, 6 fathoms (A.M.); Ewing Island, Port Ross, Auckland Islands, Cape Exped. (A.M.); Emergency Bay, Auckland Islands, 6 fathoms (A.M.); Auckland Islands, Finlay Coll. (A.M.); off Leeward Island, Antipodes Islands, 15 fathoms, R. K. Dell, -/11/50 (D.M.); Ringdove Bay, Antipodes Islands, under stones, R. K. Dell, -/11/50 (D.M.); Waitangi, Chatham Islands, shell sand (G.S., A.M., Geol. Dept. (A.U.); Waitangi, in pools, on algae, under stones, W.R.B. Oliver, 8/12/09 (D.M.); Chatham Islands, Exped. Stat. 32, off Waitangi, 7 fathoms, M.V. "Alert", 31/1/54 (D.M.); Port Hutt, Chatham Islands, shell sand; 8/2/54, (Chatham Islands Exped.) (D.M.); Red Bluff, Chatham Island, W. R. B. Oliver, 6/12/09 (D.M.); Tioriori, Chatham

Islands, Dell. Coll. (D.M.); Chatham Islands Exped. Stat. 16, Kaingaroa, shell sand, 27/1/54 (D.M.); Chatham Islands Exped. Stat. 38, South of Little Mangere, 43 fathoms, M.V. "Alert", 2/2/54 (dead shells) (D.M.); Chatham Islands Exped. Stat. 13, off Owenga, 4-6 fathoms, 27/1/54 (D.M.). *Subfossil*: Motunau Raised Beach (Hawera Series) (Upper Pleistocene) (G.S.).

Distribution: South of East Cape and the Wellington West Coast (but probably extending further North), and the East (and West?) coasts of the South Island, Stewart Island, Fiordland, Snares, Auckland, Antipodes and Chatham Islands, typically living in the littoral zone.

Ecology: In the northern part of its range, *E. rekohuana* lives under stones on the lower part of the shore, while *E. zosterophila* is found in coralline algae. Further south *E. rekohuana* completely replaces *E. zosterophila*, and is found in coralline algae, under stones and occasionally living on brown algae. Thus it occupies the same habitats as does *E. zosterophila* in the northern part of the North Island.

Estea rekohuana lactorubra n. subsp. Pl. 17, figs. 10, 11; Pl. 18, fig. 11.

Shell rather large for genus, spire slightly convex, whorls lightly convex. Protoconch of two whorls, dome-shaped, with about 20 fine spiral series of punctures, dark red in colour and terminated by a very weak varix. Adult whorls smooth, except for weak growth lines, sutures weakly impressed. Spire reddish, with a milk-white band below the suture in fresh specimens but this tending to become obscure when dried; body whorl yellowish white, except for a brown blotch just behind the aperture which is a remnant of a wide, brown, basal spiral, (better developed in some paratypes), which is faint in the holotype. A brown blotch on inner lip. Aperture typical of genus, moderately large, slightly angled above. Periphery and base evenly rounded.

The new subspecies differs from *E. rekohuana rekohuana* in having a proportionately longer spire and a rather different colour pattern. There is some relationship with *E. zosterophila* shown by the shape and the presence of a basal spiral band, but it differs from that species in being of a larger size, and having a paler colour pattern in which the basic colour is red rather than brown. The relative size of the aperture also separates it from *zosterophila*, but relates it to *rekohuana*, as does the general coloration. On consideration of the distribution and relationships of the forms involved, it seems best considered to be a subspecies of *rekohuana*.

Animal: Very similar to *E. zosterophila*. Colour of exposed animal largely grey, because of scattered black pigment cells in the integument. Cephalic tentacles transparent white, the sole dense white. Snout greyish, the tip unpigmented and bilobed; buccal mass dark grey. Short posteriorly beating, cilia on ventral sides of rather short club-shaped, flattened, cephalic tentacles, while rather long stationary cilia are situated distally. Eyes moderately large, on swellings at outer bases of tentacles. An unpigmented, ciliated groove extends down right side of animal on to side of foot. Foot rather long, anterior end rounded, mucous slit extending from middle region of sole to posterior end. Penis (pl. 17, fig. 10) long and slender, coiled behind head in about $1\frac{1}{2}$ coils, tip tapered to a sharp point.

The animal removed from its shell is seen to have a similar arrangement of the organs as those of *E. zosterophila.*

Operculum: (Pl. 17, fig. 11). Similar to *E. zosterophila.* Oval, columella marginal area rather wide, outer marginal area indistinct. Muscle insertion area distinct, marked with faint, irregular lines.

Radula: Very similar to *E. zosterophila* in tooth shape and cusp formula.

Holotype: (Pl. 18, fig. 11). Smugglers' Bay, Whangarei Heads, under stones embedded in sand in rock pools at low tide, W.F.P., 6/5/62 (A.M.).

Height 3.125 mm. Width 1.45 mm.

Paratypes: Auckland, Dominion and Canterbury Museums, N.Z. Geological Survey, Lower Hutt.

Material Examined:

Holotype and paratypes; Spirits Bay, shell sand (Hipkins Coll.); Waiau Beach, Mangonui, shell sand, E. R. Richardson, 11/12/50 (D.M.); Taupo Bay, Whangaroa, shell sand, E. R. Richardson, 11/4/51 (D.M.); Tapeka Point, Russell, -/1/52 (Hipkins Coll.) and 8/1/39, R. K. Dell (D.M.); Peach Cove, Whangarei Heads (Powell Coll.); Smugglers Bay, Whangarei Heads, under stones, -/5/63 (W.F.P.); Poor Knights Islands, under stones in rock pools, 4/4/64 (W.F.P.); Bream Tail, under stones, 12/8/63 (W.F.P.); Laing's Beach, Mangawai, shell sand, (Hipkins Coll.); Okupu, Great Barrier Island, under stones, -/11/63 (W.F.P.); Goat Island Bay, Leigh, under stones (Hipkins Coll. and W.F.P.); Noises Islands, G. Sadler (Powell Coll.); Motutapu Island, under smooth stones at half tide (Powell Coll.); Tawharanui Point, North side, under stones on papa platform, 31/12/63 (W.F.P.); Jackson's Bay, Coromandel Peninsula, under stones, 29/3/64 (W.F.P.).

Distribution: The North East of the North Island under stones in the littoral zone.

Ecology: This subspecies prefers open coasts and has never been found anywhere but under stones in the lower littoral zone. These may be embedded in sand or resting on coarser material, but *E.r. lactorubra* is not commonly found on stones with many encrusting organisms on the under surface. Papa rock platforms and rock pools are the most favoured localities.

Estea rekominor rekominor Laws. **Plate 21, fig. 12.**

1940 *Estea rekominor* Laws, Trans. Roy. Soc. N.Z., 70, p. 50, pl. 6, fig. 15.

The shell of this species is smooth, with a distinctly D-shaped aperture, the inner lip of which is nearly horizontal. The only sculpture is of growth lines, but in some paratypes axial growth striae are moderately strong on the last half of the body whorl. All of the paratypes are very similar though a few are slightly more slender than the holotype. The protoconch is finely punctate as in other members of the genus.

Holotype: (Fig. 12). Nukumaru, South Taranaki (Nukumaruan) (G.S.).

Height 2 mm. Width 1.025 mm.

Material Examined: Holotype and paratypes. Nukumaru Brown Sands (G.S.).

Distribution: Nukumaruan, lower Pleistocene.

Estea rekominor cadus Laws. Plate 21, figs. 13, 13a.

1950 *Estea cadus* Laws, N.Z. G.S. Pal. Bull., 17, p. 20, pl. 2, fig. 11.

This subspecies is very close to *E.r. rekominor* in shape and has the same type of aperture with a nearly horizontal inner lip. In the holotype there are low, rather irregular axials developed on back of the body whorl, the last quarter being smooth. Apparently only strongly developed growth rugae, they occur in approximately the same frequency as the striae on the spire whorls. Most paratypes develop the axials at the beginning of the body whorl, which is smooth over the last third. There is a weak subsutural cord on the last $1\frac{1}{2}$ whorls.

Some specimens of *E.r. rekominor* develop weak axial rugae, while *E.r. cadus* is occasionally nearly smooth. *Cadus* is usually a little smaller than *rekominor,* but the two subspecies are obviously very closely related.

Holotype: (Fig. 13). Otahuhu Well (Opoitian) (G.S.).
Height 1.6 mm. Width 0.875 mm.

Material Examined: Holotype and paratypes.

Distribution: Opoitian, lower Pliocene.

Estea rufoapicata (Suter). Plate 20, figs. 6-8.

1908 *Rissoa rufoapicata* Suter, Proc. Malac. Soc. London 8, p. 28, pl. 2, fig. 21.
1913 *Rissoa (Rissoa) rufoapicata* Suter; Suter, Man. N.Z. Moll. p. 201, pl. 12, fig. 4.
1915 *Estea rufoapicata* (Suter); Iredale, Trans. N.Z. Inst. 47, p. 454.
1955 *Estea rufoapicata* (Suter); Powell, D.S.I.R. Cape Exped. Series Bull., 15, p. 63, fig. 79.
1956 *Estea rufoapicata rufoapicata* (Suter); Dell, Dom. Mus. Bull., 18, p. 63, fig. 79.
1956 *Estea rufoapicata latior* Dell. Dom. Mus. Bull., 18, p. 63, fig. 82.

E. rufoapicata is a handsome southern species with irregular axial ribs, which are variably developed in strength and number. In the lectotype the last four whorls have weak, rounded axials, and the reddish protoconch is minutely pitted in spiral series. The first two adult whorls are reddish, with a narrow white band below the suture, while the third whorl is purplish and the body whorl white.

Dell's "subspecies" *latior* is a large finely sculptured form while his 'typical' *rufoapicata* from the Chatham Islands is a small form with few, strong axials (Dell 1956, fig. 79). The lectotype and some paralectotypes of *E. rufoapicata* are intermediate between these extremes, while other paralectotypes are indistinguishable from some paratypes of *latior.* Specimens sometimes attain a height of over 4 mm. (fig. 8).

Lectotype: 50 fathoms, Snares Islands (G.S.).
Height 3.6 mm. Width 1.6 mm.

Material Examined:

Lectotype and paralectotypes; 60 miles East of Lyttelton, 100 fathoms (Powell Coll.); B.S. 190, 45° 45.4' S., 171° 5' E., off East Otago Coast, Canyon C., in 300 fathoms, M.V. "Alert", 16/8/55 (types of *latior*) (D.M.); 60 fathoms off Otago Heads (Finlay Coll.) (A.M.) and (G.S.); 72 fathoms off Cape Saunders,

Otago, Laws Coll. (A.M.); 170 fathoms off Puysegur Point (Powell Coll.); Portobello "Alert" Station 54-17, Canyon A, E.N.E. of Taiaroa Heads, 260-350 fathoms, 28/3/54 (D.M.); 50 fathoms, Snares Islands, Finlay Coll. (A.M. and D.M.); Chatham Islands Exped. Stat. 34, 44° 04' S., 175° 23.5' E., East of Forty Fours, 130 fathoms (D.M.).

Distribution: The South East and South of the South Island, the Snares Islands and the Chatham Islands, in deep water.

Estea rugosa (Hutton). Plate 20, fig. 4.

1885 *Rissoa rugosa* Hutton, Trans. N.Z. Inst., 17 (1884-85), p. 321.
1893 *Rissoa rugosa* Hutton; Hutton, Macleay Mem. Vol., Plioc. Moll. p. 65, pl. 8, fig. 66.
1915 *Rissoa* (*Alvania*) rugosa Hutton; Suter, G.S. Bull., 3, p.5.
1924 *Estea rugosa* (Hutton); Finlay, Trans. N.Z. Inst., 55, p. 487.

The lectotype (fig. 4) is a large shell with the first $3\frac{1}{2}$ adult whorls strongly axially sculptured, but there are only traces of axials crossing the much stronger spiral cords on the body whorl. There is a spiral groove cutting off the top portion of the axials on all the whorls except the first. This gives the appearance of a nodulose spiral cord below the sutures on the spire whorls, though this cord is nearly smooth on the body whorl. On all the whorls there is a fairly wide smooth groove above the suture. The axials extend into this groove on the last part of the antepenultimate, forming a nodulose spiral rib above the suture, and a second is added on the penultimate. There are two weak spiral grooves which pass over the first part of the penultimate in the lower half of the whorl. These become stronger and form spiral cords on the body whorl. Thus on the body whorl there are 5 spiral cords, the second and third being the weakest. The base is nearly smooth with only traces of spiral sculpture. The protoconch consists of $1\frac{3}{4}$ whorls, and is moderately tall, with many, minutely punctate, spiral lines. The spire is slightly convex, while the whorls are very lightly convex and cut in at the sutures. The aperture is ovate, and angled posteriorly, and the peristome is thickened as in other *Estea* species.

Some paralectotypes show slight variation from the lectotype, having 6 main spiral cords on the body whorl and 3 weak ones on the base. Others have moderately strong axials developed on the body whorl. Most other specimens seen were a little smaller than the lectotype.

Lectotype: (Fig. 4). (Chosen by H. Suter). Petane (Nukumaruan) (Cant. Mus.).

Height 4.3 mm. Width 1.75 mm.

Material Examined: Lectotype and paralectotypes; Pohangina (Duntroonian) Laws Coll. (Geol. Dept. A.U.); Wilkes Bluff (Waitotaran) Laws Coll. (Geol. Dept. A.U.); Wilkes Bluff (Waitotaran) Laws Coll. (Geol. Dept. A.U.); Nukumaru (Nukumaruan) Laws Coll. (Geol. Dept. A.U.); Onga Onga Road, Hawkes Bay, (Nukumaruan) (G.S.); Petone (Nukumaruan) (G.S.).

Distribution: Duntroonian, lower Oligocene to Nukumaruan, lower Pleistocene.

This species is interesting in showing an intermediate condition between the axially and spirally sculptured species of *Estea*. It is closely related to *E. semisulcata* (Hutton) and *E. polysulcata* Finlay, but bears

little resemblance to the typical axially-ribbed *Estea* species such as *E. impressa*.

Estea semiplicata Powell. **Pl. 17, figs, 5, 6; Pl. 21, fig. 10.**

1927 *Estea semiplicata* Powell, Trans. N.Z. Inst., 57, p. 543, pl. 28, fig. 17.

E. semiplicata can be identified by the rather strong ribs on the penultimate and body whorl; the moderately large size, and the dark brown coloration. The spire is conical and slightly convex to nearly straight, with broad axial folds developed on the body whorl and the last part of the penultimate whorl. The spire whorls are typically fairly smooth but weak axial growth rugae do develop in many specimens.

There is considerable variation in width and coloration. All the shells are varying shades of brown, but the narrow form, like the holotype, usually has a wide yellow band, while in the broader form the band is either narrow or absent.

Intermediate forms do occur in a few localities, but I have never found the broad and narrow varieties living together, though they are found together as dead shells in shell sand (e.g. Tryphena, and Smugglers Bay). The broad form lives in compact *Corallina* in fairly sheltered, silted conditions, while the narrow shells are typically found living in exposed, clean situations, usually living on short algae. However there is no evidence to indicate that the two forms should be separated. Occasional evidence of hybridization with *E. zosterophila* is seen (see p. 133).

Animal: External pigmentation dark grey to nearly black, rather more heavily pigmented than other species of the genus. Snout dark grey, bilobed, short; buccal mass black. Sole white, with a mucous slit extendnig from centre to posterior edge. Cephalic tentacles short, club-shaped, with active cilia on ventral surface, long stationary cilia distally. Eyes moderately large, on slight swellings at outer bases of tentacles, with a group of white gland cells behind. Penis (pl. 17, fig. 6) thick, wide, coiled about $1\frac{1}{2}$ times, tip sharply pointed. The anatomy is described elsewhere (Ponder—a).

Operculum: Very similar to that of *E. rekohuana lactorubra* n. subsp.

Radula: (Pl. 17, fig. 5). As in *E. zosterophila* but lateral cusp formula $2 + 1 + 2$, and outer marginal with larger denticles (about 9) than the inner (about 11).

Holotype: Taupo Bay, Whangaroa (Powell Coll.).
Height 2.375 mm. Width 1.15 mm.

Material Examined:

Holotype and paratypes; between Cape Maria van Diemen Island and mainland, 4 fathoms, -/2/61 (Hipkins Coll.); Spirits Bay, shell sand, (Hipkins Coll.); Kapuwairua, Spirits Bay, -/1/57 (Powell Coll.); Parengarenga, Laws Coll. (Geol. Dept. A.U. and G.S.); Waiau Beach, Mangonui, E. R. Richardson, 11/12/50 (D.M.); Whatuwhiwho, Doubtless Bay, under stones (Hipkins Coll.); Taupo Bay, Whangaroa, shell sand, E. R. Richardson, 11/4/51 (D.M.); off Reach Island, Whangaroa, $4\frac{1}{2}$ fathoms (W.F.P.); Cavalli Islands, Whangaroa, algae, -/6/52 (D.M.); Tapeka Point, Russell, Bay of Islands, -/1/52 (Hipkins Coll.); off Russell, 8 fathoms, R. K. Dell, -/1/39 (D.M.); Whangaruru (W.F.P.); Smugglers Bay, Whangarei Heads, shell sand, short red algae, 5/5/62 (W.F.P.); Ocean Beach, Whangarei Heads, *Carpophyllum plumosum*, short algae, 7/5/62 (W.F.P.);

Taurikura Bay, Whangarei Heads, coralline algae, under stones, -/5/63 (W.F.P.); dredged off Mokohinau Islands (dead shells) (W.F.P.); Okupu, Great Barrier Island, under stones, -/11/63 (W.F.P.); off Great Barrier Island, 8-10 fathoms, Dell Coll. (D.M.); Whangaparapara, Great Barrier Island, on reef, R. K. Dell, Dell Coll. (D.M.); Tryphena, Great Barrier Island (Geol. Dept. A.U., Hipkins Coll., G.S.) and 6-10 fathoms (G.S.); Goat Island Bay, Leigh (W.F.P.); Leigh, Dell Coll. (D.M.); Noises Islands, G. Sadler (Powell Coll.); Jackson's Bay, Coromandel, coralline algae, *Carpophyllum plumosum*, fine red algae, 29/3/64 (W.F.P.); Stony Bay, Coromandel, in coralline and other short algae growing on boulders, 28/3/64 (W.F.P.); Mayor Island, 35-80 fathoms (Powell Coll.); Cape Runaway, (A.M.).

Fossil: Otahuhu Well, (Opoitian) Laws Coll. (Geol. Dept. A.U.), (1 juvenile); Te Piki (Castlecliffian) Laws Coll. (Geol. Dept. A.U.).

Distribution: Opoitian to recent. The present geographical distribution is the North East of the North Island in the littoral zone and extending into a few fathoms.

Ecology: *E. semiplicata* lives on coralline and other short algae, and under stones in the littoral zone. At Taurikura Bay, Whangarei Heads, *Corallina* samples were taken from various points around a small island just offshore (High Island), which indicated that marked changes occurred in the local distribution of *E. semiplicata.* On the sheltered, shore-facing side of the island, the "broad form" was very abundant, together with the rissoinid *"Austronoba" carnosa* (Webster), while on the more exposed outer side, *E. zosterophila* was the most abundant mollusc.

Remarks: The Australian *E. salebrosa* Frauenfeld, is very similar in build and texture to *E. semiplicata,* but differs in details of size, shape and sculpture. Iredale (1955) has provided the genus *Feldestea* for this species. However *E. semiplicata* has many points in common with the type of *Estea* and there is even evidence of occasional interbreeding between these two species. Shell sculpture is not a good guide to relationship in *Estea,* and any related genera or subgenera that are based primarily on sculpture alone, should be regarded rather doubtfully. There appears to be no good reason to retain *Feldestea* as a subgenus, let alone a full genus. Coan (1964) places *Feldestea* in the subfamily Rissoinae, while he puts *Estea* in his Cingulinae. This is a good example of the over-emphasis placed on shell sculpture in the *rissoids. Estea semiplicata* belongs to a different line from *E. impressa* (Hutton), while *E. rufoapicata* (Suter) and *E. manawatawhia* Powell, also belong to independent lines which have developed axial ribs.

Estea semisulcata (Hutton). Plate 20, figs. 1-3.

1885 *Rissoa semisulcata* Hutton, Trans. N.Z. Inst., 27, p. 301.
1893 *Rissoa semisulcata,* Hutton; Hutton, Macleay Mem. Vol., Plioc. Moll., p. 66, pl. 8, fig. 69.
1915 *Rissoa (Onoba) semisulcata* Hutton; Suter, N.Z. Geol. Surv. Pal. Bull. 3, p. 5.
1924 *Estea semisulcata* (Hutton); Finlay, Trans. N.Z. Inst., 55, p. 487.
1934 *Estea semisulcata* (Hutton); Powell, Trans. Roy. Soc. N.Z., 64, p. 155.

The species is characterised by the smooth spire and the strong spiral cords developed on the body whorl. The number of spirals is fairly constant, usually being 5 on the body whorl, but small shells often have only 4. The spirals commence on about the last quarter of the penultimate whorl in the majority of specimens, but this does vary somewhat, especially between populations. In some (e.g. Turakina Road,

Hunterville) the spirals commence after the first third of the penultimate whorl, while in recent specimens from off Whangaroa there are fine spiral cords on all adult whorls except the first. The strength of the spiral cords is usually fairly constant, being low, broad, and rounded, with narrow interstices, though these are much weaker in occasional specimens (e.g. a few shells from Castlecliff have the spirals subobsolete, even on the body whorl). Specimens from off Whangaroa show weaker cords and rather wider interstices than most fossils.

The species shows a considerable range of variation in size and development of the spiral sculpture on the spiral whorls. Powell (1934) recorded it living in the North, and recent specimens seem to be even more variable than fossils. Specimens from off Whangaroa (fig. 3) are rather different from most fossils seen, whereas those from certain other recent localities are inseparable from typical fossils. The lectotype is rather larger than normal, while all the paralectotypes are smaller (fig. 2). The colour of recent specimens (Whangaroa) is dark brown, reddish-brown, or orange-red, and the protoconch is dark red to orange red, the columellar is red to pale yellowish, and the rest of the aperture is white. The base is lighter in colour than the rest of the body whorl, usually being pale yellow-orange.

Lectotype: (Fig. 1). (Chosen by H. Suter). Wanganui (Pleistocene) (Cant. Mus.).

Height 3.7 mm. Width 1.7 mm.

Material Examined:

Fossil Lectotype and paralectotypes; Otahuhu Well (Opoitian) Laws Coll. (Geol. Dept. A.U.); Wilkies Bluff (Waitotaran) Laws Coll. (Geol. Dept. A.U.); Mangapani (Waitotaran) Laws Coll. (Geol. Dept. A.U.); Nukumaru Brown Sands (Nukumaruan) (G.S.); Nukumaru (Nukumaruan) Laws Coll. (Geol. Dept. A.U.); Hunterville, Turakino Road, (Nukumaruan) (G.S.); Takapau S.D. (Nukumaruan) (G.S.); Mangaotoro S.D. (Nukumaruan) (G.S.); Castlecliff (Castlecliffian?) Laws Coll. (Geol. Dept. A.U.); Castlecliff (Castlecliffian) (G.S.); Castlecliff 'B' (Castlecliffian) (G.S.); Waikopiro Wanganui (Castlecliffian?) (locality uncertain) (G.S.). *Recent*: 22 fathoms, ½ mile South of Stephenson's Island, 3½ miles off Whangaroa (Hipkins Coll.); Off Little Barrier, 20 fathoms (Powell Coll.); 6-10 fathoms, off West Coast of Great Barrier Island (Powell Coll.); 46-82 fathoms, N.N.E. of Mayor Island, in fish stomach contents, Coll. G. Gilliams (Powell Coll.); 50 fathoms, off South West end of Mayor Island, in fish stomach contents, Coll. G. Williams (Powell Coll.).

Distribution: Opoitian to Recent. The recent distribution is in moderately deep water in the North East of the North Island.

Estea subfusca (Hutton). Pl. 17, figs. 12, 13; Pl. 18, figs. 12-16.

1873 *Rissoa subfusca* Hutton, Cat. Mar. Moll., p. 28.
1909 *Rissoa* (*Cingula*) *subfusca* Hutton; Suter, Subantarctic Is., N.Z. 1, p. 17.
1913 *Rissoa* (*Cingula*) *subfusca* Hutton; Suter, Man. N.Z. Moll., p. 210, pl. 12, fig. 18.
1915 *Estea subfusca* (Hutton); Iredale, Trans. N.Z. Inst. 47, p. 454.
1928 *Estea* sp. of *zosterophila* Finlay, Trans. N.Z. Inst. 59, p. 242.
1933 *Estea subfusca* (Hutton); Powell, Rec. Auck. Inst. Mus. 1 (4), p. 200, pl. 35, fig. 7 (topotype).
1933 *Estea guesti* Powell, Rec. Auck. Inst. Mus. 1 (4), p. 200, pl. 35, fig. 5.
1955 *Estea subfusca* (Hutton); Powell, Cape Exped. Series Bull. 15, p. 84.

This species can be distinguished by its large size, straight-sided spire, smooth, shining surface and subangled periphery.

There is considerable variation in size, outline, angulation of the periphery and colour (c.f. figs. 12, 14, 15 and 16). Some of this is geographic, at least in part, but most of the variation is within populations. The shell may be unicoloured purplish, dark or light brown, or yellowish, or may have lighter bands below the suture. The base may be coloured the same as the spire or much more darkly, and this dark colour is often cut off sharply at the periphery (especially typical of Chatham Island shells). The protoconch varies from dark reddish-brown to yellowish, and is finely sculptured with many rows of minute punctures. A subsutural fold is sometimes developed with a concavity below it, and occasionally faint spiral folds are seen on the spire whorls.

E. guesti Powell agrees well with *E. subfusca* from many localities and must be considered a synonym. A series of shells from Stewart Island and Fiordland (fig. 15) was, at first, thought to be a different species, but comparison with long series show it is just a form of *E. subfusca*. It has a swollen body whorl, a larger, expanded aperture, convex whorls, and the colour is pinkish or reddish in the Stewart Island examples, but similar to typical *subfusca* in the Fiordland shells. Some samples from Stewart Island show integration of this form with *E. rekohuana* and *subfusca*. Since this form is rare at Stewart Island, it is probable that this is a hybrid which is not capable of breeding. The Fiordland shells are probably just variants of *subfusca,* as there is considerable variation in other ways. A series of shells from 100 fathoms off Puysegur Point, South West Otago, (fig. 16), are smaller, and pale, with a dark brown blotch on the base and on the columella. They are rather unlike any other specimens I have seen, but probably represent a deep-water population that has undergone partial differentiation due to isolation.

Animal: (Portobello, Dunedin Harbour). Colour of exposed animal largely dark grey owing to black pigment cells in the integument, but tips of tentacles, sole, and anterior end of snout are white. Snout short, bilobed; buccal mass dark grey. Tentacles rather short, club-shaped, compressed dorso-ventrally; eyes moderately large, on swellings at their outer bases. Foot rather short, truncated in front, anterior corners rounded, mucous slit extends from middle of sole to posterior end. Penis (pl. 17, fig. 12) muscular, wide, flattened, with a central silver-coloured line, about two coils, tip pointed, attached to the animal in mid-dorsal line a fair distance behind tentacles.

Operculum: (Pl. 17, fig. 13). Thin, transparent, oval, flattened, Nucleus small, lateral, of about two revolutions, the first revolution tiny and slightly thickened. A weak line emerging from the nucleus, runs down middle of operculum. On columella side of this line growth lines obscured by longitudinal, irregular markings, giving the surface a wavy appearance. Outer-side of line sculptured with faint growth lines only. The marginal area rather narrow, extending right around operculum. A slightly thickened patch on columella side of right end.

Radula: Similar to that of *E. zosterophila*. Central 2 + 1 + 2, with 2 basal processes. Lateral 2 + 1 + 2, with a long outer portion. Inner marginal with about 18 fine denticles, outer marginal appears to be smooth.

Holotype: (Fig. 12). Stewart Island (D.M.).
Height 2.8 mm. Width 1.375 mm.

Material Examined:

Holotype; Dunedin Harbour, Finlay Coll. (A.M.); Portobello, Dunedin Harbour, brown algae, soft red algae, under stones 3/9/63 (W.F.P.) and Finlay Coll. (A.M.); Ships' Channel side of Quarantine Island, Dunedin Harbour, fine red algae, coralline algae, 4/5/63 (W.F.P.); Bluff, oyster dredgings, -/9/56 (W.F.P.); Bluff, Finlay Coll. (A.M.); Foveaux Strait (G.S.) and Suter Coll. (G.S.); Middle Grounds, Foveaux Strait, 15-30 fathoms, O. Allan, -/6/51 (D.M.); Ulva Island, Paterson Inlet, Stewart Island, O. Allan, -/1/48 (D.M.) and E. Smith, -/1/48 (Powell Coll.); Stewart Island, 15 fathoms, A. Hamilton (Powell Coll.); Mason's Bay, Stewart Island, O. Allan, -/8/48 (D.M.); Port Pegasus, Stewart Island, 8-18 fathoms, M.V. "Alert" (G.S.), 16 fathoms, Suter Coll. (G.S.) and 5 fathoms, M.V. "Alert", 23/11/47 (D.M.); Bathing Beach, Stewart Island, O. Allan, 1950 (D.M.) and E. Smith (Hipkins Coll.); Halfmoon Bay, under stones, R. K. Dell, 30/10/48 (D.M.); Halfmoon Bay, Stewart Island, under stones, M. Spong, -/3/64 (W.F.P.); off Puysegur Point, 100 fathoms (D.M.); B.S. 104, Chalky Inlet, 20 fathoms, M.V. "Alert", W. H. Dawbin, 6/5/50 (D.M.); Dusky Sound, 30 fathoms, R. Henry (D.M.); B.S. 106, between Unnamed Island and Breaksea, Dusky Sound, 20 fathoms, W. H. Dawbin, M.V. "Alert", 7/5/50 (D.M.); B.S. 137, off Passage Point, Dusky Sound, 12-15 fathoms, M.V. "Alert", W. H. Dawbin, 8/1/52 (D.M.); Doubtful Sound, 50 fathoms, (W.F.P. and Hipkins Coll.); B.S. 107, Gaol Passage, Doubtful Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 8/5/50 (D.M.); B.S. 110, inside entrance to George Sound, 15-20 fathoms, W. H. Dawbin, M.V. "Alert", 10/5/50 (D.M.); B.S. 185, Casewell Sound, 10 fathoms, M.V. "Alert", R. K. Dell, 23/3/49 (D.M.); B.S. 109, Bligh Sound, 25 fathoms, M.V. "Alert", W. H. Dawbin, 10/5/50 (D.M.); Snares Island, under stones, lower midlittoral, G. Knox, 29/1/61 (D.M.); Snares Islands, 50 fathoms, Finlay Coll. (A.M.); Waitangi, Chatham Islands, shell sand, A. W. B. Powell, -/2/53 (holotype and paratypes of *E. guesti* Powell) (A.M.); Waitangi, shell sand (G.S.); Chatham Islands Exped. Stat. 32, Waitangi, 7 fathoms, 3/1/54 (D.M.); Waitangi, in rock pools and on algae between tides, W. R. B. Oliver, -/12/09 (D.M.); Chatham Islands Exped., Port Hutt, Chatham Islands, shell sand, 8/2/54 (D.M.); Chatham Islands Exped. Stat. 16, Kaingaroa, R. K. Dell, 27/1/54 (D.M.); Chatham Islands Exped. Stat. 13, Owenga, 4-6 fathoms, R. K. Dell, 27/1/54 (D.M.); Chatham Islands Exped. Stat. 38, South of Little Mangere, 43 fathoms, M.V. "Alert", 2/2/54 (D.M.); Chatham Islands Exped. Stat. 2, 42° 50.4' S., 175° 30.4' E., Mernoo Bank, 61 fathoms, 23/1/54 (D.M.). *Subfossil*: Motunau Raised Beach (Hawera Series), (Upper Pleistocene) (G.S.).

Distribution: The south of the South Island, Stewart Island, and the Snares and Chatham Islands, from the lower littoral zone to moderately deep water.

Estea subrufa Powell. Plate 21, figs. 14-16.

1937 *Estea subrufa* Powell, Disc. Rep. 15, p. 197-198, pl. 53, fig. 2.

The paratypes of *E. subrufa* are very variable (figs. 14, 15, 16). Some have fairly prominent axial ribs (fig. 14), and though these are apparently absent in the holotype, most paratypes have them developed to some extent. The species can be recognised by its small size, weak irregular axials, rounded, rather small aperture and short, inflated, conical, pinkish-red spire. The body whorl is white in large specimens, and at least half white in others.

Holotype: Discovery II Stat. 933 off Three Kings Islands in 260 metres (Brit. Mus.).
Height 2 mm. Width 1 mm. (from Powell)

Material Examined:

Paratypes (Powell Coll.); Discovery II Stat. 932, off Three Kings Islands,

185 metres (Powell Coll.); 4 fathoms, between Cape Maria Island and mainland, -/2/61 (Hipkins Coll.); Spirits Bay (Hipkins Coll.).

Distribution: Extreme North of New Zealand.

Subgenus MICROESTEA n. subgen.

Type: *Estea angustata* Powell, 1927

Shell similar to *Estea* in general form, but much thinner and more fragile, with a cylindrical, blunt-topped, spire. Protoconch dome-shaped, with exceedingly minute punctures in close spiral lines. Adult whorls smooth except for a subsutural cord and growth lines. Aperture large, expanded, pyriform, the angle posterior; inner lip broadly expanded, outer lip a little thickened, and an indistinct channel basally.

Animal, operculum and radula unknown.

Estea (Microestea) angustata angustata Powell. Plate 19, fig. 9.

1927 *Estea angustata* Powell, Trans. N.Z. Inst., 57, p. 543, p. 27, fig. 10.

This species is easily recognised by its cylindrical spire, reddish spire whorls, minute size, and fragile shell. It has no sculpture except for a broad subsutural rib.

Holotype: (Fig. 3). Mangonui, 6-10 fathoms (Powell Coll.).
Height 1.625 mm. Width 0.525 mm.

Material Examined:

Holotype and paratypes; Discovery II Stat. 933, off the Three Kings, 260 metres (A.M.); 5 fathoms between Cape Maria Island and mainland, -/2/62 (Gardner Coll.); Tom Bowling Bay, shell sand (Gardner Coll. and Powell Coll.), Spirits Bay 1949 (Hipkins Coll.), Taputaputa, -/1/57 (Gardner Coll.); 22 fathoms, ½ mile South of Stephenson's Island, off Whangaroa (Hipkins Coll.); off Mayor Island, taken from fish stomachs, G. Williams (Powell Coll.).

Distribution: Far North and the North East of New Zealand, living in moderately deep water.

Estea (Microestea) angustata jacosa Laws. Pl. 19, figs, 10, 11.

1940 *Estea jacosa* Laws, Trans. Roy. Soc. N.Z., 70, p. 48, fig. 32.

Closely related to *E. angustata* Powell, *E. jacosa* is here considered subspecific, and perhaps ancestral, to the recent form. The fossil differs in shape, in having a much weaker subsutural cord and fairly prominent axial growth striae. The paratypes are rather worn but show the striae behind the aperture. The recent subspecies has only very weak growth lines. The holotype has the protoconch missing but this can be seen in a paratype (fig. 11).

Holotype: (Fig. 10). Wilkie's Bluff, South Taranaki (Waitotarian) (G.S.).

Height 1.6 mm. (estimated) Width 0.6 mm.

Material Examined: Holotype and paratypes (G.S.).

Distribution: Waitotarian.

A List of the New Zealand Recent and Fossil Species of ESTEA

Estea Iredale, 1915. (= *Feldestea* Iredale 1955, *Nodulestea* Iredale 1955).

E. zosterophila zosterophila (Webster, 1905).
**E. zosterophila ngatutura* Laws, 1941.
E. asymmetrica Laws, 1941.
E. hipkinsi n. sp.
E. impressa (Hutton, 1885) (= *E. verticosta* Powell and Bartrum, 1929).
**E. insulana insulana* Marwick, 1928.
E. insulana porrecta Powell, 1933 (= *E.* c.f. *insulana* Powell, 1933, and Dell, 1960).
E. insulana porrectoides Powell, 1937.
**E. koruahina* Laws, 1941.
E. manawatawhia Powell, 1937.
E. micronema micronema (Suter, 1898) (= *E. subtilicosta* Marwick, 1928, and *E. sculpturata* Dell, 1956).
E. micronema morioria Powell, 1933.
E. minor (Suter, 1898).
**E. missile* Laws, 1940.
**E. polysulcata* Finlay, 1924.
E. praecidecosta n. sp.
E. rekohuana rekohuana Powell, 1924.
E. rekohuana lactorubra n. subsp.
**E. rekominor rekominor* Laws, 1940.
**E. rekominor cadus* Laws, 1950.
E. rufoapicata (Suter, 1908) (= *E. rufoapicata latior* Dell, 1956).
**E. rugosa* (Hutton, 1885).
E. semiplicata Powell, 1927.
E. semisulcata (Hutton, 1885).
E. subfusca (Hutton, 1873) (= *E. guesti* Powell, 1933).
E. subrufa Powell, 1937.
(*Microestea*) n. subgen.
E. (*M.*) *angustata angustata* Powell, 1927.
**E.* (*M.*) *angustata jacosa* Laws, 1940.
* — Only known as a fossil.
= — Synonym.

APPENDIX I. Approximate specific time ranges.

International Correlation	N.Z. Stage	asymmetrica	impressa	micronema	missile	koruahina	semiplicata	rugosa	semisulcata	polysulcata	insulana	zosterophila	z. ngatutura	rekohuana	minor	subfusca	rekominor	r. cadus	a. jocosa
Recent		X	X	X			X		X			X		X	X	X			
Pleistocene	——		X											X	X	X			
	Castlecliffian		X		X		X		X			X							
	Nukumaruan		X	X	X			X	X	X	X						X		
	Hautawan		?					?											
Pliocene	Waitotaran		X		X				X										X
	Waipipian							X											
	Opoitian		X			X	X?		X				X					X	
Miocene	Altonian	X																	
Oligocene	Awamoan																		
	Hutchinsonian																		
	Otaian	X?	X																
	Waikakian																		
	Duntroonian		X					X							X? (aff.)				

KEY: X occurrence; X? specific identity questioned; ? stage questioned; → suggested evolutionary origin.

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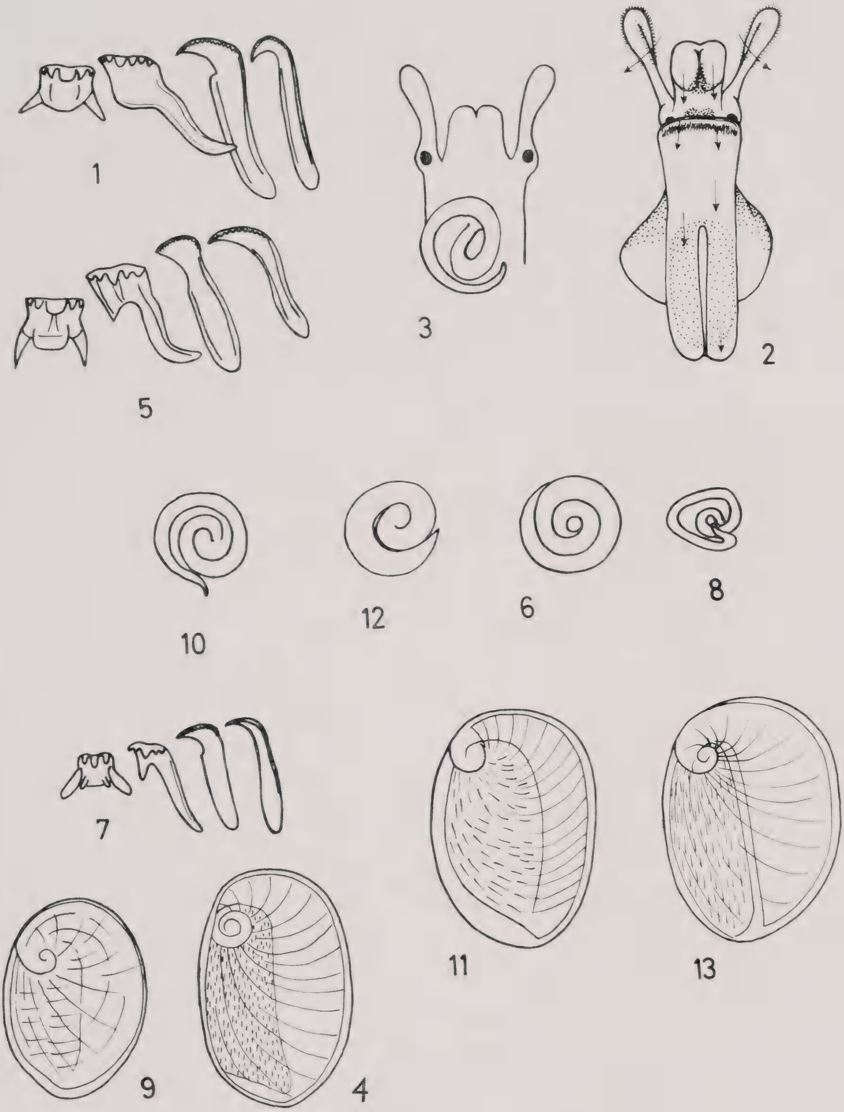
PLATE 17



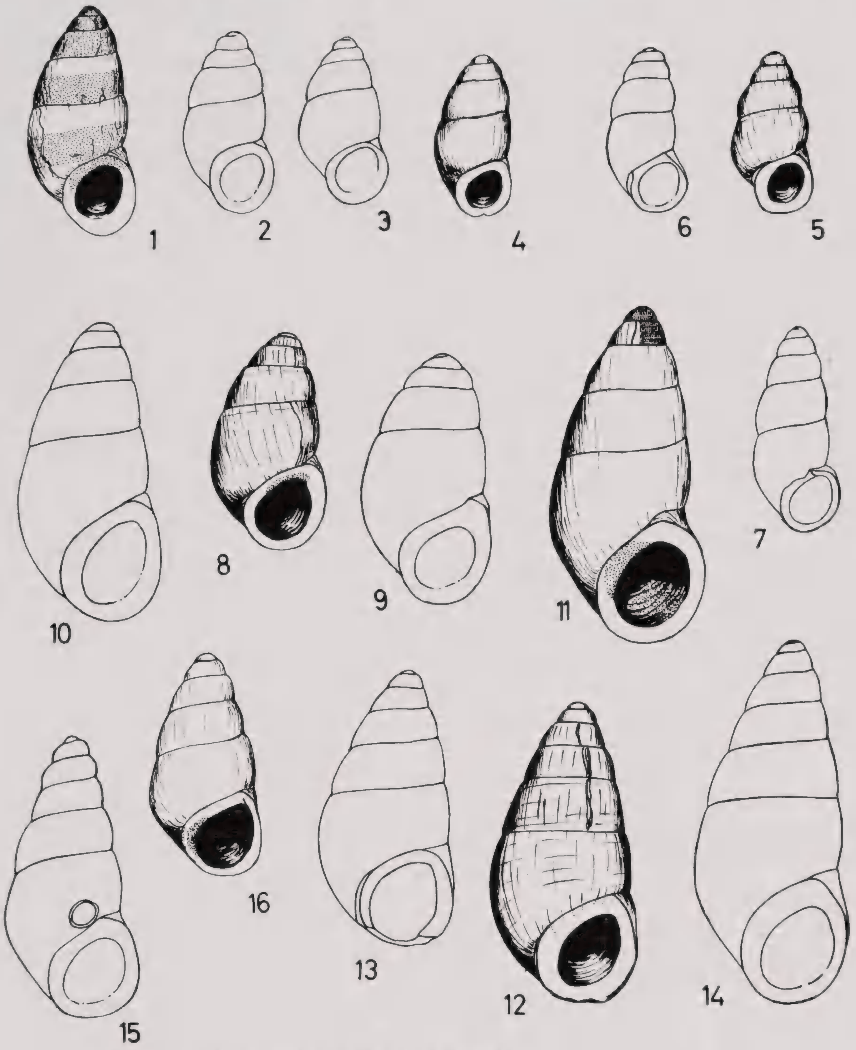
Estea zosterophila (Webster).
Figs. 1. Radula. 2. Ventral view of animal.
3. Dorsal view of animal and penis.
4. Operculum (inner side).

Estea semiplicata Powell.
Fig 5. Radula. 6. Penis.

Estea impressa (Hutton).
Fig. 7. Radula. 8. Penis.
9. Operculum (inner side).

Estea rekohuana lactorubra n. subsp.
Fig. 10. Penis. 11. Operculum (inner side).

Estea subfusca (Hutton).
Fig. 12. Penis. 13. Operculum (inner side).



Estea zosterophila zosterophila (Webster).
Fig. 1. Lectotype, 2.15 x 0.975 mm.
2. Takapau Kura, Spirits Bay, 1.675 x 0.8 mm.
3. Takapau Kura, Spirits Bay, 1.55 x 0.8 mm.

Estea zosterophila ngatutura Laws.
Fig. 4. Holotype, 1.5 x 0.7 mm.

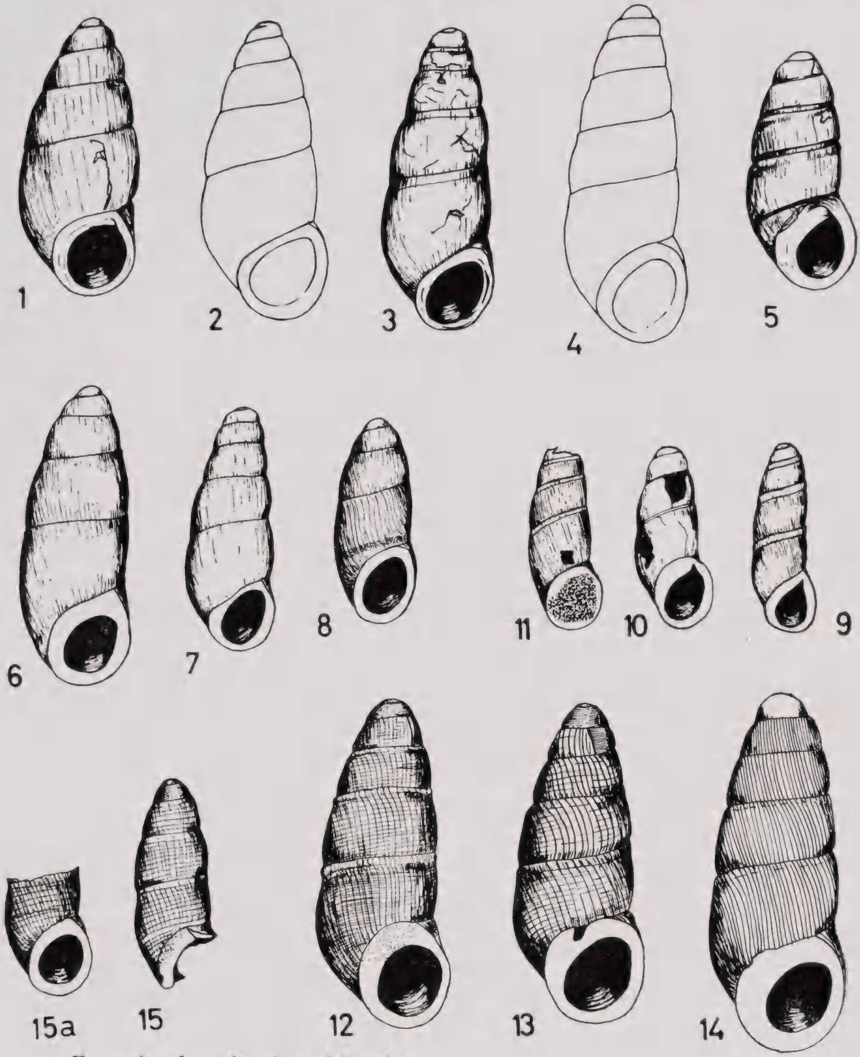
Estea minor (Suter).
Fig. 5. Lectotype, 1.5 x 0.7 mm.
6. Paralectotype, 1.55 x 0.725 mm.

Estea aff. *minor* (Suter).
Fig. 7. Waimumu, 1.9 x 0.775mm.

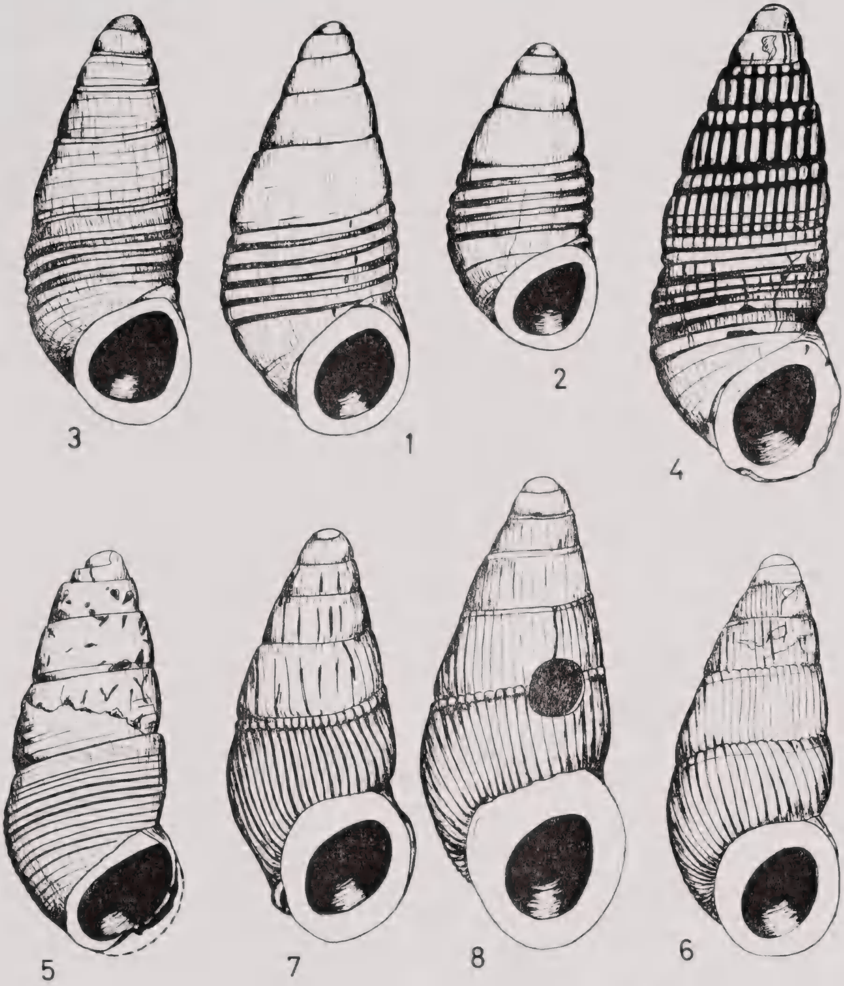
Estea rekohuana rekohuana Powell.
Fig. 8. Holotype, 2.0 x 1.075 mm.
9. Carnley Harbour, Auckland Islands, 2.325 x 1.2 mm.
10. Ulva Island, Stewart Island, 2.75 x 1.3 mm.

Estea rekohuana lactorubra n. subsp.
Fig. 11. Holotype, 3.125 x 1.45 mm.

Estea subfusca (Hutton).
Fig. 12. Holotype, 2.8 x 1.375 mm.
13. Holotype of *E. guesti* Powell, 2.6 (estim.) x 1.25 mm.
14. Port Pegasus, Stewart Island, 3.375 x 1.4 mm.
15. Ulva Island, Stewart Island (subfusca x rekohuana), 2.6 x 1.2 mm.
16. 100 fathoms, Puysegur Point, South-West Otago, 2.05 x 1.0 mm.



Estea insulana insulana Marwick.
Fig. 1. Holotype, 2.4 x 1 mm.
Estea insulana porrecta Powell.
Fig. 2. Cape Young, Chatham Islands (close to *insulana insulana*), 2.55 x 1.1 mm. 3. Holotype 2.575 x 0.95 mm.
3. Holotype 2.575 x 0.95 mm.
4. South of Little Mangere, Chatham Islands, 2.9 x 1.05 mm.
Estea missile Laws.
Fig. 5. Holotype, 2.025 x 0.9 mm.
Estea insulana porrectoides Powell.
Fig. 6. Paratype, 2.55 x 0.925 mm.
7. Discovery II Stat. 929, 2.1 x 0.225 mm.
8. Spirits Bay, 1.775 x 0.65 mm.
Estea (Microestea) angustata angustata Powell.
Fig. 9. Holotype, 1.625 x 0.525 mm.
Estea (Microestea) angustata jacosa Laws.
Fig. 10. Holotype, 1.6 (estim.) x 0.6 mm. 11. Paratype, 1.6 x 0.625 mm.
Estea micronema micronema (Suter)
Fig. 12. Lectotype, 2.825 x 1.15 mm.
13. Holotype of *E. sculpturata* Dell, 2.725 x 1.1 mm.
14. Holotype of *E. subtilicosta* Marwick, 3.1 x 1.15 mm.
Estea micronema morioria Powell.
Fig. 15, 15a. Holotype (2 fragmentary specimens) 1.9 (estim.) x 0.7 (estim.) mm. (Fig. 15).



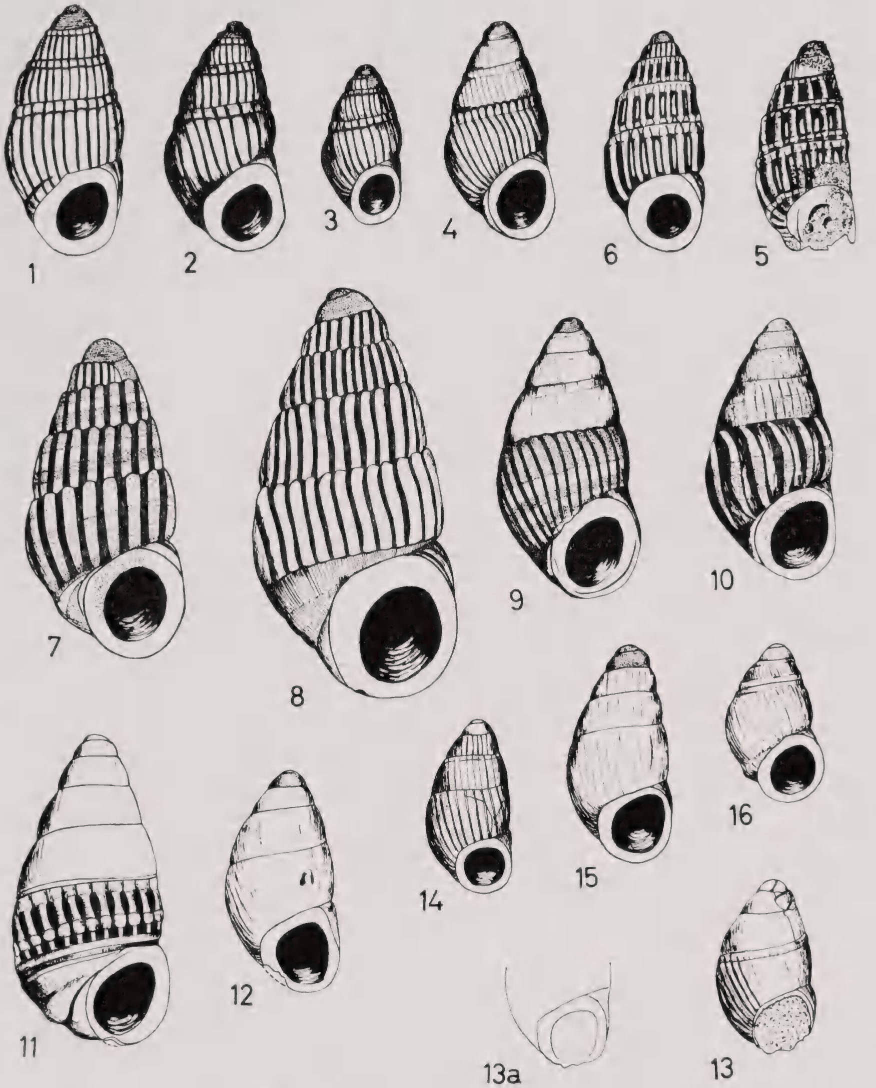
Estea semisulcata (Hutton).
Fig. 1. Lectotype, 3.7 x 1.7 mm.
2. Paralectotype, 2.75 x 1.4 mm.
3. 22 fathoms off Stephenson's Island, off Whangaroa, 3.675 x 1.5 mm.

Estea rugosa (Hutton).
Fig. 4. Lectotype, 4.3 x 1.75 mm.

Estea polysulcata Finlay.
Fig. 5. Holotype, 3.6 (estim.) x 1.6 (estim.) mm.

Estea rufoapicata (Suter).
Fig. 6. Lectotype, 3.6 x 1.6 mm.
7. Holotype of *E. rufoapicata latior* Dell, 3.7 x 1.7 mm.
8. Paratype of *E. rufoapicata latior* Dell, 4.3 x 1.85 mm.

PLATE 21



Estea impressa (Hutton).
Fig. 1. Lectotype, 2.275 x 1.05 mm.
2. Leigh (large form) 2.1 x 1.1 mm.
3. Leigh (small form) 1.425 x 0.7 mm.

Estea olivacea (Frauenfeld).
Fig. 4. Sydney, New South Wales, Australia, 2.0 x 0.95 mm.

Estea asymmetrica Laws.
Fig. 5. Holotype, 1.95 x 0.875 mm.
6. Off Mayor Island, 2.0 x 0.9 mm.

Estea manawatawhia Powell.
Fig. 7. N.Z.O.I. Stat. C. 760, 2.9 x 1.4 mm.

Estea praecidecosta n. sp.
Fig. 8. Holotype, 3.7 x 1.775 mm.

Estea hipkinsi n. sp.
Fig. 9. Holotype, 2.375 x 1.25 mm.

Estea semiplicata Powell.
Fig. 10. Holotype, 2.375 x 1.15 mm.

Estea koruahina Laws.
Fig. 11. Holotype (reconstructed) 2.8 x 1.45 mm.

Estea rekominor rekominor Laws.
Fig. 12. Holotype, 2.0 x 1.025 mm.

Estea rekominor cadus Laws.
Fig. 13. Holotype, 1.6 (estim.) x 0.875 mm.

Estea subrufa Powell.
Fig. 14. Paratype, 1.6 x 0.775 mm. 15. Paratype, 2.0 x 0.95 mm.
16. Paratype, 1.45 x 0.75 mm.

New Zealand Molluscan Systematics with Descriptions of New Species: Part 5

By A. W. B. POWELL, Auckland Museum.

ABSTRACT.

In this part five new species and five genera new to the New Zealand Recent fauna are described or recorded; a surprise item is a new species of the Mediterranean architectonicid genus *Gyriscus*. Of special note is the great increase of the subtropical element, represented by the recording of the first New Zealand Recent occurrence of a true cypraeid, a large porcellanous *Polinices* and the subtropical or tropical *Annaperenna verrucosa, Pomiscala perplexa, Bulla (Quibulla) subtropicalis* n.sp. and *Atys naucum*. The large North Queensland *Latirus gibbulus*, recorded on the basis of one empty shell is noted but further records are required before this exotic species can be admitted as a natural occurrence in the New Zealand fauna.

Family EPITONIIDAE

Genus POMISCALA Iredale, 1929

Type (o.d.): *Scala perplicata* Iredale, 1929.

Pomiscala perplexa (Pease, 1867). Plate 22, fig. 4.

1867—*Scalaria perplexa* Pease, Amer. Journ. Conch., 3(4), p.288.
1915—*Epitonium perplexum* (Pease): Oliver, Trans. N.Z. Inst. 47, p.530.

This is a new record for New Zealand; based upon a fresh but empty and slightly damaged shell, found in a rock pool at Paxton Point, an isolated locality near the southern end of Great Exhibition Bay, Northland, by Mr Norman Douglas, 16th July, 1964. It measures 22.5 mm. in height and 10.75 mm. in width.

The New Zealand shell is identical with specimens in the Auckland Museum from Sunday Island (Raoul Island), Kermadecs, taken by Mr R. S. Bell about 1910, and both are inseparable from a series in the author's collection, from the type locality, Hawaiian Islands.

The New South Wales shells recorded by Hedley (Journ. Roy. Soc. N.S.W. 51, pM65) as this species were renamed *perplicata* nov. by Iredale (1929, Austr. Zool. 5(4), p.344), on the basis of more varices per whorl, 12-13, as against 9-10 for *perplexa*, which always has a dark brown subsutural band, this being absent in *perplicata*.

This signifies that the species owes its presence in New Zealand waters to some south west Pacific current, rather than the East Australian Current, the factor responsible for most of the recently acquired exotic elements in our fauna.

Family ARCHITECTONICIDAE

Subfamily TORINIINAE

Genus GYRISCUS Tiberi, 1867

Type (monotypy) *Gyriscus jeffreysiana* Tiberi, 1867.

Gyriscus asteleformis n.sp. Plate 22, fig. 11.

Shell trochiform, with a broadly conical spire of lightly rounded whorls and a broadly rounded periphery. Base with a very deep and

narrow umbilicus. Aperture subcircular or transversely broadly-ovate; peristome continuous only as a thin callus across the parietal wall. Columellar-lip free and broadly reflected, partially encroaching upon the umbilical area. Protoconch relative large, smooth and almost completely inverted, so that the nuclear umbilicus shows as a small pit, only slightly off top centre. Adult sculpture of linear spaced finely and closely gemmulate spiral cords, 6-8 on the spire-whorls and continuing over the body-whorl and base to just within the umbilical cavity. One of the cords, just below the level of the aperture, is slightly stronger than the rest, and those over the middle part of the base alternate between wider and narrower somewhat flatter spirals, less distinctly granulated. Colour uniformly buff. Operculum externally horny, multispiral, with a central nucleus as a small smooth sunken pit, remaining whorls with lamellate raggedly sinuous upcurved edges; internally calcified, with a bounding broad raised spiral ridge and a central projecting sharply tapered peg. The operculum resembles a drawing-pin or "thumb tack", and is exactly like the one figured for the Mediterranean *jeffreysiana*, type of the genus (Tyron, 1887, Manual of Conch.9, pl.1, fig.17). The shell of the Mediterranean species differs only in having a taller spire and coarser spiral sculpture.

Height 8.0 mm.; width 7.5 mm.

Locality: Between the Three Kings Islands and Cape Maria van Dieman, 50 fathoms, in the cavity of a cup-sponge.

Holotype—Presented to the Auckland Museum by Mr K. Hipkins.

This is a remarkable addition to our fauna since the type species of the genus belongs to the Mediterranean.

Family CYMATIIDAE

Genus ANNAPERENNA Iredale, 1936

Type (o.d.) *Ranella verrucosa* Sowerby, 1825 = *Murex papilla* Wood, 1828.

Annaperenna verrucosa (Sowerby, 1825). Plate 22, figs., 5,6.

1825—*Ranella verrucosa* Sowerby,Cat.Coll.Tankerville,Append.,p.18.
1828—*Murex papilla* Wood, Supp. Index Test.p.14,pl.5(*Murex*),fig.2.
1910—*Argobuccinum papilla* (Wood),Iredale,Proc.Malac.Soc.9,p.73;
1915—*Bursa papilla* (Wood), Oliver,Trans.N.Z.Inst.47,p.528.
1936—*Annaperenna verrucosa* (Sowerby), Iredale,Rec.Aust.Mus.19,p.310.

Type locality: Probably Norfolk Island (Iredale, 1936). Also known from Lord Howe Island, Kermadec Islands, and from Sydney Harbour dredge spoil.

This is another subtropical genus and species, that can now be added to the New Zealand faunal list on the basis of two fresh specimens taken by the Whangarei underwater group at the Poor Knights Islands.

The species is most distinctive on account of the heavy rounded tubercles which are dark brown, against a pale cream ground. The maculations have slightly diffused edges which imparts a scorched look to the tubercles. One of the Poor Knights Islands specimens (fig. 6) is not fully adult, which shows in the nature of the maculations on the tubercles, for they are dashes rather than heavy rectangular spots, as shown in a Kermadec topotype (fig. 5). However, the second specimen, taken off the southern tip of the Poor Knights, is adult and has the large maculations.

Height, 35.0 mm.; width, 22.5 mm. Raoul Island, Kermadec Islands.
Height, 35.0 mm.; width, 21.5 mm. Poor Knights Islands.

Localities (New Zealand)—Poor Knights Islands, off the northern tip of Tawhiti Rahi Island, at the foot of a steep cliff-face at about 150 feet, in sand and rubble (Mr J. Voot, 1965); off the southern tip of Aorangi Island, at about 50 feet (Mr B.Anderson, 1965).

Family NATICIDAE

Genus POLINICES Montfort, 1810

Type (o.d.) *Polinices albus* Montfort, 1810 = *Nerita mammilla* Linnaeus, 1758.

Polinices tawhitirahia n.sp. Plate 22, figs. 1-3.

Another striking find by the Whangarei members of the Underwater Club, from off the Poor Knights Islands, was this large solid porcellanous *Polinices,* which is very similar to the common tropical South West Pacific shell, long known as "*mammilla* Linnaeus, 1758". It is very doubtful, however, if the name *mammilla* can be retained for the tropical Pacific shells since Linnaeus quoted the locality of his species as "Habitat ad Barbados", which if correct, would make this a prior name for the West Indian shell known as *Polinices lacteus* (Guilding, 1834), and the Indo-Pacific *mammilla* auct. would then become *pyriformis* (Recluz, 1844). This latter action has already been taken by Rippingale and McMichael (1961, Queensland and Great Barrier Reef Shells, p. 91).

Other tropical Pacific shells, approaching *mammilla* auct. in size, solidity and porcellanous appearance are *albula* Recluz, 1851 and *flemingiana* Recluz, 1844, the former from Amboina and Wallis Island, the latter from the Philippines. However, not one of these species matches the Poor Knights material, which is characterised by a low bluntly conical spire, is never umbilicate and shows an unusual tendency for the callus pad to completely cover the umbilical area in juvenile and half grown examples, but to exhibit a crescentic cleft or deep groove around the lower edge of the callus in mature shells.

A large white *Polinices* recently described by Mr T. A. Garrard (1961,Journ.Malac.Soc.Austr.5,p.18), as *putealis,* resembles the Poor Knights shells in outline but the parietal callus is relatively slight, leaving a deep umbilical cavity which extends right through to the spire.

It is not certain that the Poor Knights species is a recent derivitive from tropical Pacific stock, for this type of naticoid was very abundant in New Zealand in the middle and upper Tertiary to as late as the Otahuan stage of the lower Pliocene. Therefore, the Poor Knights species could represent a northward straggling relict from a local warmer water upper Tertiary fauna. The Norfolk Island record is of intertst in this connection also, for local stock could have been driven northward during cooling post-Pliocene times, and may now be in the process of repopulation southward, under present assumed more favourable conditions.

Description: Shell large, 25-30 mm. in height, very solid, porcellanous-white, rather wide, with a low broadly conical spire. Aperture semilunar. Parietal callus heavy, entirely sealing the umbilicus in juvenile and half-grown examples, but in mature shells, there is a well marked crescentic groove defining the outer edge of a large funicle that is entirely covered with callus; in no example is there a perforate umbilical cavity.

Height	width	
30.0 mm.	26.5 mm.	Norfolk Island.
28.0 mm.	26.0 mm.	Poor Knights Islands (holotype).
27.0 mm.	25.0 mm.	Poor Knights Islands (paratype).
25.5 mm.	23.0 mm.	Poor Knights Islands (paratype).
20.0 mm.	18.0 mm.	Poor Knights Islands (paratype).

Localities: New Zealand, at the northern tip of Tawhiti Rahi, Poor Knights Islands, off the Northland east coast, at about 120 feet, in sand and rubble at the foot of a steep cliff face (Mr W. Palmer and his associates, February, 1965) (no living examples were taken but all are in a fresh uneroded state) (holotype and paratypes); Norfolk Island, one dead shell from the cable in 45-50 fathoms, just south of the island (Mr W. Foster,C.S."Recorder",1934).

Family CYPRAEIDAE

Genus EROSARIA Troschel, 1863

Type (s.d. Jousseaume, 1884): *Cypraea erosa* Linnaeus, 1758.

Erosaria cernica tomlini Schilder, 1930. Plate 23, figs. 15-19.

1915—*Cypraea flaveola* Linnaeus:Oliver,Trans.N.Z.Inst.47,p.526 (not of Linnaeus, 1758).
1930—*Erosaria cernica tomlini* Schilder,Proc.Malac.Soc.19,p.51.
1939—*Erosaria tomlini prodiga* Iredale,Austr.Zool.9(3),p.307.
1956—*Ravitrona tomlini* Schilder:Allan, Cowry Shells of World Seas,p.93.
1958—*Ravitrona tomlini kermadecensis* Powell,Rec.Auck.Inst.Mus.5(1-2),p.79, pl.10,fig.5.
1962—*Cypraea (Erosaria) cernica viridicolor* Cate, Veliger,4(4),p.175,pl.40, figs.1-9.
Type localities:—*tomlini* (Lifu,Loyalty Island); *prodiga* (Newcastle, New South Wales); *kermadecensis* (Raoul Island,58-60 metres, Kermadec Islands); *viridicolor* (Northwest Cape, Western Australia).

Mr W. Palmer and his associates of a Whangarei underwater club, have added this interesting new record to our fauna, the first true cypraeid to be found in New Zealand waters. These specimens were taken in a very fresh state, but not actually living, at a depth of about 120 feet, at the northern extremity of the Poor Knights Islands, off the Northland east coast. Since then a badly worn specimen was located in an assortment of beach shells from the island at Cape Maria van Diemen, collected by Mr F. Young in 1933.

The New Zealand specimens seem to be identical with the Kermadec shells, one from Lord Howe Island and others from New South Wales localities. There is a name available for the New South Wales shells in Iredale's *tomlini prodiga* but it seems that all the above-mentioned material is not significantly different from Schilder's *tomlini,* from the Island of Lifu. Again, there is little tangible evidence to segregate Cate's *viridicolor* from Western Australia.

Measurements and apertural denticle counts, as shown in the following table, indicate these features to be quite variable, even within local populations, and would thus appear to have no significance.

On the other hand, *cernica* is readily distinguished by its broadly arched dorsum, with laterally spread sides, pale coloration with a white spotted honey coloured dorsum, and rather pale and more sparse lateral brown spots. Typical *cernica* is represented in the Australian Museum collections from Mauritius (type locality), Bombay, India, New Hebrides and Bampton Reefs, Coral Sea. Schilder considered *cernica* to be precinctive to the Lemurian Region. I am indebted to Dr D. F.

McMichael for the opportunity of examining the fairly extensive material of this group in the Australian Museum collections.

Two other geographic subspecies of *cernica* have been described: *ogasawarensis* Schilder, 1945 from Japan and *marielae* Cate, 1960 from Hawaii, but neither of these names have direct bearing upon the identity of the New Zealand shell.

Measurements in mm.			Denticles		
Length	width	height	outer lip	columellar lip	locality
31.00	20.00	16.00	-	19	Poor Knights Islands
30.50	18.00	14.75	18	18	Kermadec Islands
30.00	18.00	-	19-20	14	Type of *prodiga*
29.00	18.5	15.00	18	19	Poor Knights Islands
28.75	19.00	15.00	20	18	Kermadec Islands
28.20	18.50	13.80	20	17	*viridicolor* (paratype)
28.00	18.00	15.00	15	18	Broken Bay, N.S.W.
27.75	17.50	14.00	16	15	Lord Howe Island
27.50	18.50	14.75	20	19	Kurnell, N.S.W.
27.50	18.00	15.00	18	18	Poor Knights Islands
27.50	17.00	14.00	18	14	Kermadec Islands
27.50	17.50	14.00	19	19	Poor Knights Islands
24.50	16.00	12.50	18	18	Sydney, N.S.W.
24.00	15.00	11.75	18	18	Type of *kermadecensis*
23.75	14.25	11.50	17	16	Paratype of *kermadecensis*
21.40	14.40	10.80	18	14	Holotype of *viridicolor*
21.00	13.00	10.75	16	16	Cape Maria van Dieman

Description of Poor Knights Islands material.—Shell shining, rather highly polished. Dorsum dark honey-coloured to organe-brown with evenly sprinkled but irregularly sized pale spots. Sides, base, teeth and interior, porcellanous white. Margins coarsely pitted, and others sparsely and irregularly distributed along the sides. Outer lip denticles varying between 18 and 19, columellar denticles also 18 and 19 and fossula denticles 4 to 6. The columellar teeth are rather evenly graded, not stepped, and extend about one-fifth of the way across the base . In the holotype of *kermadecensis* the columellar teeth extend over one third across the base but in other Kermadec material, a quarter to a fifth is the usual extent.

Localities—NEW ZEALAND: Poor Knights Islnds, northern end of Aorangi at entrance to cave at about 60 feet, on sand amongst rubble and boulders (Mr W. Palmer; 4 specimens examined but over 20 examples known to have been taken by his associates); amongst beach debris at Cape Maria van Dieman (island) (Mr F. Young, 1933; one very worn and bleached specicen).

Family FASCIOLARIIDAE

Genus LATIRUS Montfort, 1810.

Type (o.d.): *Murex filosus* Lamarck (based upon Martini Chemnitz, Conch. Cab. 4, pl. 141, figs. 1308, 1309 = *Murex gibbulus* Gmelin, 1790)

Latirus gibbulus (Gmelin, 1790). Plate 23, fig. 12.

1790—*Murex gibbulus* Gmelin,Syst.Nat.ed.13,p.3557 (based upon Knorr,5,pl.10, fig.4).
1816—*Fusus filosus* Lamarck,Ency.Meth.vers.,pl.429,Liste,p.7.
1840—*Fusus filosus* Lamarck; Kiener, Icon.Coq.Viv.p.40,pl.21,fig.1.
1847—*Turbinella gibbula* (Gmelin),Reeve,Conch.Icon.4,pl.7,fig.36 (New Holland).
1881—*Latirus gibbulus* (Gmelin); Tryon,Man.of Conch.3,p.88,pl.67,fig.117 and pl.68,fig.126.
1909—*Latirus gibbulus* (Gmelin);Hedley,Austr.Assoc.Adv.Sci.sect.D,Biology. Presid. Address,p.365 (recorded Queensland).

A well preserved example of this handsome shell, three inches in height (76 mm.), was picked up on Mimiwhangata Beach, east coast, north of Whangarei, by Mrs B. C. le Clerc of Helena Bay, in 1963. There is some doubt as to whether this shell was a natural occurrence, or whether it originated from some vessel. Mrs le Clerc mentioned that HMNZS Lachlan anchored in the vicinity for some days after a Pacific cruise, and just prior to the finding of the shell, which came ashore amongst storm wrack. The species is evidently quite rare and seems to belong exclusively to the North Queensland fauna, an area not visited by the Lachlan during the above mentioned cruise.

However, unless corroborative evidence is forthcoming it is not advised that the species be added to our faunal list at present.

The shell is very solid with a broadly rounded submedian angulation, and sculptured with broadly rounded axials, 8-9 per whorl, more or less confined to the peripheral area. The external colour of the shell is brown-orange, narrowly spirally lined in dark chocolate. Interior of aperture and parietal callus pale pink to salmon.

Family VOLUTIDAE

Genus **PACHYMELON** Marwick, 1926.

Subgenus **PALOMELON** Finlay, 1927.

Type (o.d.) *Cymbiola lutea* Watson, 1882.

Pachymelon (Palomelon) grahami n.sp. Plate 23, fig. 14.

Shell very small for the genus, solid, ovate, with a short spire, about two thirds the height of the aperture. Whorls evenly rounded except for the last whorl which is very faintly shouldered. Aperture sublunate with a thick rounded lip, especially thickened over the shoulder area to the suture. Protoconch large, blunt, cylindrical of 2½ smooth whorls. Adult sculpture of numerous rounded axial folds, extending from suture to suture and over the whole of the body-whorl, but becoming progressively weaker over the lower part of the base. Anterior notch wide and shallow; fasciole weak and not margined. Columella with four evenly developed slightly oblique folds. Colour uniform pinkish-buff.

Height, 32.5 mm.; width, 15.3 mm.

Locality: Off Oamaru in 50 fathoms, trawled by Mr. J. Graham of Oamaru.

This is a dwarf species, far smaller than any other Recent species, and only exceeded in smallness by the Opoitian,lower Pliocene *powelli* Laws, 1936, (fig. 13) from Kaawa Creek. The Kaawa shell, which measures 28 mm. in height, differs from the Recent species in having an excavated shoulder slope, a less flared outer-lip, and much weaker axial sculpture, which is reduced over the shoulder sulcus and subobsolete over most of the body-whorl.

Holotype: Presented to the Auckland Museum by Mr J. Graham.

Family TURRIDAE

Genus **AUSTRODRILLIA** Hedley, 1918.

Subgenus **REGIDRILLIA** Powell, 1942.

Type (o.d.) *Austrodrillia* (*Regidrillia*) *sola*, Powell, 1942.

Austrodrillia (Regidrillia) secunda n.sp. Plate 22, fig. 7.

Shell of moderate size, strong, elongate-claviform, with a tall

turreted spire, slightly greater than height of aperture plus canal. Protoconch of about $2\frac{1}{2}$ whorls, the first $1\frac{1}{2}$, a broad depressed tip, smooth except for a low-set prominent narrowly rounded carina; succeeding whorl taller and with regular widely spaced narrow crisp axials, additional to the carina, which gradually rises to a median position. The protoconch passes imperceptibly into the adult sculpture, except for the gradual development of a subsutural fold, which becomes obsolete before the penultimate is reached. Adult sculpture of slightly oblique heavy rounded axials, strongest at the median weak angulation, extending over most of the base, but weak over the shoulder slope and not quite reaching the suture. Spiral sculpture overriding the axials, consisting of fine crisp crowded threads on the shoulder slope, two stronger cords on the spire whorls, one peripheral, the other below, towards the lower suture, and six additional cords on the base, plus five more closely spaced, on the slight anterior fasciole. Body-whorl rather long and narrow, gradually tapered to a short anterior canal, with a wide but not emarginate termination. Aperture rather narrow, with a thin edged outer lip, which, however is very heavily variced behind. Sinus deep, U-shaped, occupying the lower half of the shoulder slope, constricted above by a very massive callus, adjoining the suture and the parietal wall. Colour buff to light brown, conspicuously banded with a broad subperipheral reddish-brown zone and another at the anterior end. The species differs from *sola* Powell, 1942, the only other known species of the subgenus in being of a much more slender shape, with a more depressed and more strongly carinated protoconch, and a much more massive parietal callus pad.

Height, 10.5 mm.; width 4.0 mm.

Localities: Great Barrier Island (N. Gardner) (holotype); trawled, Bay of Plenty (collection of Mr N. Gardner).

Holotype: In the Auckland Museum, presented by Mr N. Gardner.

Family BULLIDAE

Genus BULLA Linnaeus, 1758

Subgenus QUIBULLA Iredale, 1929.

Type (o.d.) *Bulla botanica* Hedley, 1918.

Bulla (Quibulla) subtropicalis n.sp. Plate 22, figs. 8, 9.

A shell picked up on Ocean Beach, Whangarei Heads, by Mr J. R. Penniket, and three beach specimens from the island at Cape Maria van Dieman, differ from the common local *quoyi* (Gray, 1843) at sight; they are of more cylindrical form, with the outer lip bent inward above and medially, and the apical cavity is a minute straight-sided perforation, not slightly perspective as in *quoyi*. The colour pattern differs also in being irregularly pale speckled on a light reddish-brown ground, and only obscurely banded in the form of moderate to large diffused blotches in darker reddish brown. Interior of aperture and columellar callus white. No spiral striae on the base, a characteristic feature of *quoyi*.

This is the shell found commonly at Norfolk Island and at the Kermadecs, from whence it was recorded by Oliver (1915,Trans.N.Z. Inst.47,p.542) as *Bullaria peasiana* Pilsbry (1893,Man. of Conch.15, p.348), which was a new name for the preoccupied *Bulla marmorea* Pease, 1860 (Proc.Zool.Soc.,p.431), type from the Hawaiian Islands.

The Hawaiian *peasiana* is a much more elongated shell, with flatter sides and a considerable taper to the rather narrow apical area.

Height	width	(Measurements in mm.)
30.00	19.00	Norfolk Island
28.00	18.00	Norfolk Island
27.00	17.00	Norfolk Island (holotype)
24.00	15.25	Kermadec Islands
24.25	15.50	Kermadec Islands
22.00	14.00	Ocean Beach, Whangarei Heads
21.00	13.00	Kermadec Islands

Localities: Norfolk Island (A.W.B.P.coll.,Auck.Mus.); Sunday Island (Raoul Island), Kermadecs (A.W.B.P.coll.,Auck.Mus.); New Zealand, Ocean Beach, Whangarei Heads (Mr J. R. Penniket); Cape Maria van Dieman (island) (Mr F. Young, 1933); the island, Kapowairua, Spirits Bay (N. Gardner, 1964).

Holotype: Auckland Museum (Norfolk Island).

Family ATYIDAE

Genus ATYS Montfort, 1810.

Type (o.d.): *Atys cymbulus* Montfort, 1810 = *Bulla naucum* Linnaeus, 1758.

Atys naucum (Linnaeus, 1758).

1758—*Bulla naucum* Linnaeus,Syst.Nat.,10th.ed.,p.726(Asia).
1810—*Atys cymbulus* Montfort,Conchyl.Sys.2,p.343.
1855—*Bulla naucum* Linnaeus,Sowerby,Thes.Conch.2,p.584,pl.124,figs.107-109 (Philippines and Borneo;Cuming).
1929—*Atys naucum* (Linnaeus),Iredale,Austr.Zool.5(4).p.348 (New South Wales, Sydney Harbour dredgings).
1952—*Atys naucum* (Linnaeus),Habe,Illustr.Cat.Japanese Shells,no.20,p.137 (Japan).

This comparatively large white-shelled opisthobranch is usually associated with the tropics, but Iredale (1929) recorded it from as far south as Sydney Harbour, where it was taken in spoil from dredging operations. Now I am able to record the finding of two specimens from New Zealand. These were not fully grown, but were in a fresh condition, although not containing the animal. They were washed up at about twelve months interval, at Snell's Beach near Warkworth, north of Auckland. I am indebted to Mr J. R. Penniket, the finder, for permission to publish this interesting record.

In addition to the localities cited in the synonymy, Philippines, Borneo, Japan and New South Wales, the species was recorded from Amboina (Rumphius, 1741). and is represented by material in the writer's collection from Magnetic and Dunk Islands, Queensland, and Kandavu, Fiji.

Height	width	
42.0 mm.	31.50 m.m.	Dunk Island (fully grown)
25.5 mm.	17.75 mm.	Shell's Beach, New Zealand.
25.0 mm.	17.50 mm.	Dunk Island, Queensland.

Figs. 1-3 *Polinices tawhitirahia* n.sp. Poor Knights Islands; holotype (fig. 2) and paratypes. Fig. 4 *Pomiscala perplexa* (Pease, 1867), Great Exhibition Bay. Figs 5, 6. *Annaperenna verrucosa* (Sowerby, 1825), Poor Knights Islands (fig. 6) and Kermadec Islands (fig. 5). Fig. 7 *Austrodrillia (Regidrillia) secunda* n.sp., Great Barrier Island (holotype). Figs. 8, 9. *Bulla (Quibulla) subtropicalis* n.sp., Norfolk Island (holotype) (fig. 8), Whangarei Heads (fig. 9). Fig. 10. *Bulla (Quibulla) quoyi* (Gray, 1843), Cheltenham, Auckland. Fig. 11. *Gyriscus asteleformis* n.sp., between Three Kings and Cape Maria van Dieman, 50 fathoms (holotype).

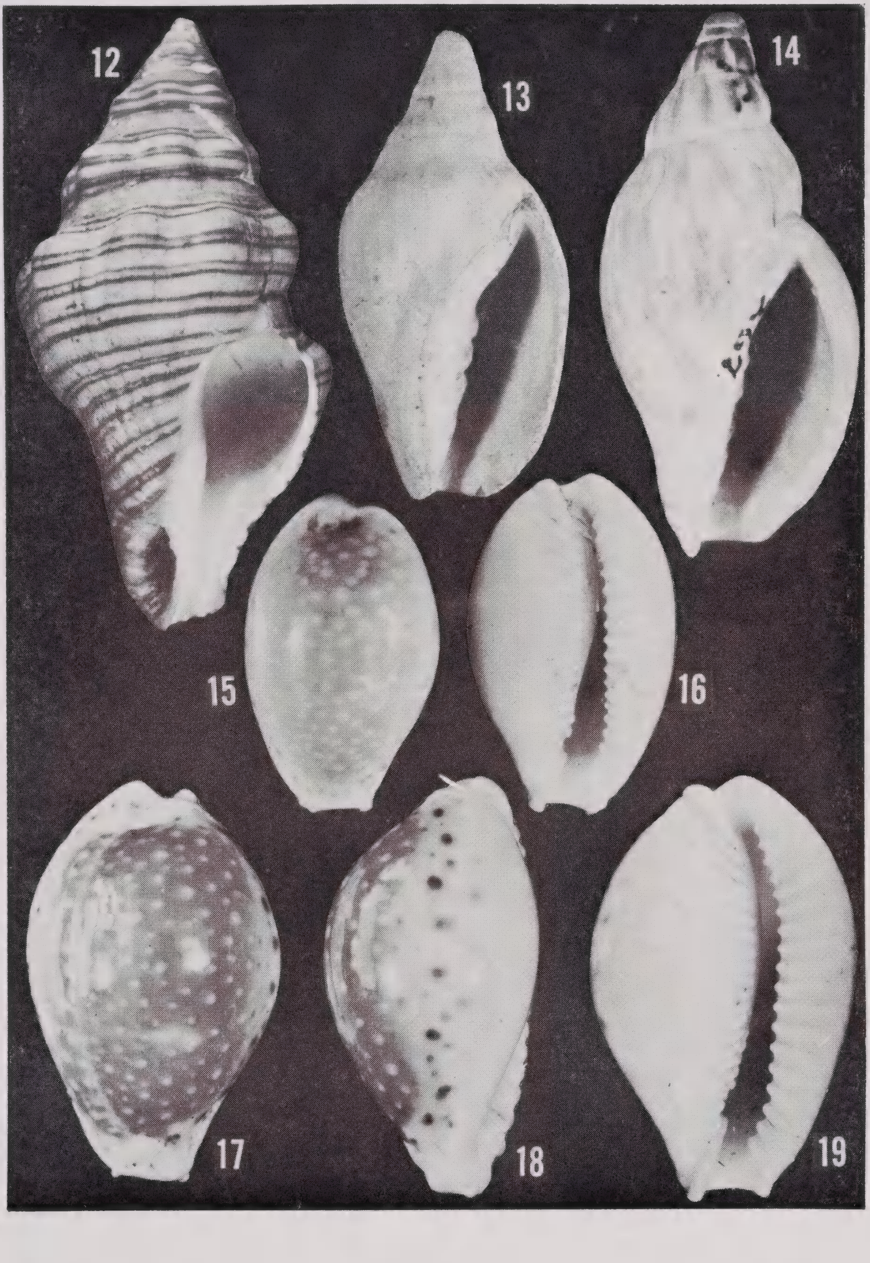


Fig. 12. *Latirus gibbulus* (Gmelin, 1790), Mimiwhangata, Northland. Fig. 13 *Pachymelon (Palomelon) powelli* Laws, 1936, Kaawa Creek, Opoitian lower Pliocene (holotype). Fig. 14. *Pachymelon (Palomelon) grahami* n.sp., off Oamaru, 50 fathoms (holotype). Figs. 15-19. *Erosaria cernica tomlini* Schilder, 1930, Raoul Island, 58-60 metres, Kermadec Islands (figs. 15, 16, holotype of *kermadecensis* Powell, 1958); Poor Knights Islands (figs. 17-19.).

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A Further Note on Tecomanthe speciosa W.R.B. Oliver (BIGNONIACEAE)

By J. A. HUNTER
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ABSTRACT

The occurrence of naturally fertilized fruits, and the establishment of seedlings under a parent vine, are recorded.

Oliver (1948, P. 233) described the single plant of *Tecomanthe speciosa* found on Great Island in the Three Kings group by Dr G. T. S. Baylis in November-December 1945. Although the plant was described as a vigorous twiner, about 20 to 30 feet high, no fruits were found. Hunter (1958, P. 41) illustrated fruits which he obtained in 1956 by hand-pollinating flowers of a cutting cultivated at Mt Albert Research Station. These fruits were quite conspicuous by December 1956, and it seemed at that time that the absence of fruits and seedlings on Great Island might be due to a faliure of pollination.

The purpose of this note is to record that hand-pollination is not always necessary for fertilization, and that seedlings will develop under a parent plant with little assistance.

In 1957 and subsequent years, the Mt Albert cutting set fruits naturally and hand-pollination was not necessary. Bees frequented the flowers and may have assisted pollination. Fruits obtained were sent to botanical centres overseas, and some seeds were raised at Mt Albert to provide plants for distribution.

In 1964 it was decided to leave the fruits to ripen on the vine, and to distribute the seeds below the parent plant. The only soil preparation was to clear weeds from the area below the plant before scattering the seeds. The seeds were sown in April 1964 and, during the winter and spring, any large weeds which grew on the site were pulled out by hand. No other help was given to assist the establishment of the seedlings.

A number of seeds germinated and the plants were photographed in mid-January 1965. The illustration shows the seedlings among fallen leaves of the parent plant. The labels are exposed about 9 cm. to mark the plants and indicate their height.

Rec. Auck. Inst. Mus. Vol. 6, No. 3, pp. 169-170, 14th August, 1967.

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Seedlings of *Tecomanthe speciosa* W. R. B. Oliver, growing under the parent "cutting" at Mt Albert Research Station. Photo: A. Underhill.

Ipomoea pes-caprae (CONVOLVULACEAE) on Ninety Mile Beach, New Zealand

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ABSTRACT

The discovery of *Ipomoea pes-caprae* (L.) Sweet on Ninety Mile Beach adds a tropical shore convolvulus to the naturalized flora of the North Island of New Zealand.

In April 1957 Mr H. G. B. Halliwell, Instructor in Agriculture, Kaitaia, sent a specimen of *Ipomoea pes-caprae* (L.) Sweet to the Botany Division, Department of Scientific and Industrial Research, Lincoln. He collected it "three miles above Brent's farm, Hukatere". The specimen (CHR 96074) is infertile, with three somewhat imperfect leaves.

In August 1966 Mr Des Ogle, Forest Ranger, Aupori State Forest, found three plants of *Ipomoea pes-caprae* in a valley in the foredune on Ninety Mile Beach, about two miles north of Hukatere Lookout. The three plants are growing about latitude S 34° 52', longitude E 173° 04'; the reference on sheet N 6 of the N.Z. topographical map series 1 : 63,360 (1 mile to 1 inch) being 565977. No other plants of this species have been found on Ninety Mile Beach and the three plants found by Mr Ogle seem to be the same occurrence as that reported by Mr Halliwell. More recently, Mr C. F. Brent of Mill Bay, Mangonui, advised that, when he was part owner of 430 acres at Hukatere, he and Mrs Brent found *Ipomoea pes-caprae* there. It was some years before they realised that it was unusual and, in 1957, asked Mr Halliwell to identify it.

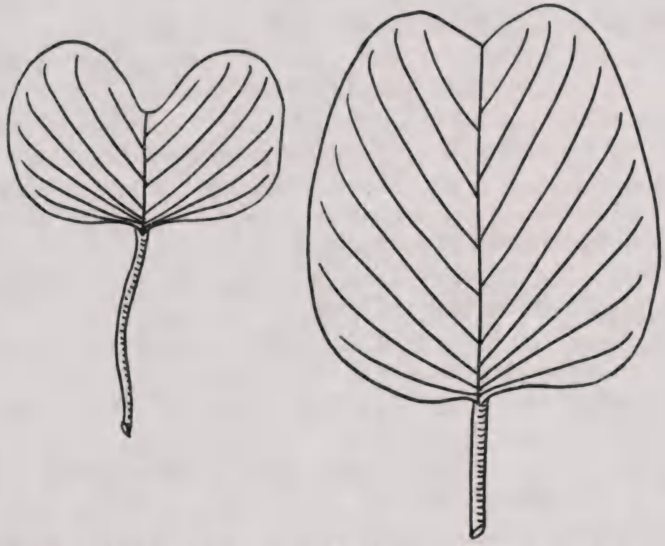

Fig.1.—Leaves of *Ipomoea pes-caprae* (L.) Sweet. Left, ssp. *pes-caprae*. Right, ssp. *brasiliensis* (L.) van Ooststr. (after van Ooststroom). Two-thirds natural size.

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Ipomoea pes-caprae belongs to the Convolvulus family, which includes the kumara or sweet potato, *Ipomea batatas* (L.) Lamk., and the bindweeds, species of *Convolvulus* and *Calystegia*. It has been recorded from Norfolk, Lord Howe and Raoul Islands, but it has not been reported previously from the mainland of New Zealand. The Ninety Mile Beach plants may not be the southernmost occurrence of the species; it seems to reach the same latitude in South Africa.

S. J. van Ooststroom, in a paper on *The Convolvulaceae of Malaysia III* in Blumea 3(3): 533, 1940, distinguished two subspecies:—

ssp. *pes-caprae,* which is restricted to the coasts of continental tropical Asia, and a few localities on the East African Coast, and

ssp. *brasiliensis* (L.) van Ooststr., which is circumtropical in distribution.

Van Ooststroom illustrated the leaves of the two subspecies, and his drawings are reproduced (text fig. 1). The plants from Ninety Mile Beach belong to ssp. *brasiliensis,* although they are less luxuriant than those found on the sanddunes of Raoul Island and other warmer shores.

The habitat of the three plants at Ninety Mile Beach is shown in Plate 25, fig. a. Two plants grow above the bend of the creek, on the north face of the dune. The angle of slope is about 45°, and the plants are sheltered from cold southerly and westerly winds. The third plant is growing some 16 m. south of the creek, on a sheltered northerly slope in a hollow in the dunes. The largest plant, on the left in figure a, covers an area about 6 m. x 5 m. The second plant, near the centre of figure a, covers an area about 4 m. x 3 m. The third plant, not shown, spreads over 2 m. x 1 m. of the sand surface. The vegetation about the three plants consists of the following:

Native Species

Spinifex hirsutus Labill. Sand grass covers the foredunes.

Cassinia retorta A. Cunn. Cottonwood or tauhinu, a shrubby member of the Compositae, is frequent on fixed dunes.

Muehlenbeckia complexa (A. Cunn.) Meissn. Pohuehue, a member of the Polygonaceae, forms tangled masses on older dunes.

Leptocarpus simplex A. Rich. Dense tussocks of jointed rush or oioi, a member of the Restionaceae, grow in wet sand at the mouth of the stream, and behind in the dunes.

Arundo conspicua Forst.f. Toetoe, a member of the Gramineae, forms large tussocks near the creek.

Scirpus nodosus Rottb. Tufts of this sedge, a member of the Cyperaceae, are common on the dunes.

Deyeuxia billardieri Kunth. Sand bent, a member of the Gramineae, is also common.

Senecio lautus Willd. Shore groundsel, a small, yellow flowered Composite, is found occasionally.

Oxalis corniculata L. Creeping yellow sorrel, a member of the Oxalidaceae, also occurs occasionally on the dunes.

Phormium tenax J. R. & G. Forst. Native flax grows near the stream.

Ipomoea palmata Forsk. This rare Convolvulus scrambles among *Leptocarpus* and *Phormium* near the stream mouth.

Cassytha paniculata R.Br. This parasite, a member of the Lauraceae, also twines through the *Leptocarpus-Phormium* community.

Lobelia anceps Linn.f. The shore lobelia is common in wet places.

Festuca littoralis Labill. Sand fescue, a member of the Gramineae, forms isolated tussocks about high-water level.

Carex pumila Thunb. Dune sedge forms a carpet from the creek to high-water level. The Landrover in Plate 25a is standing on the *Carex,* with a belt of *Leptocarpus* behind.

Selliera radicans Cav. This creeping herb, a member of the Goodeniaceae, covers areas of damp sand in the *Carex-Leptocarpus* communities.

Introduced Species

Ammophila arenaria (L.) Link. Marram grass has been planted as a sand binder, and is probably spreading naturally.

Lupinus arboreus L. Lupin has been planted widely and is common.

Briza maxima L. Quaking grass is common on the dunes.

Bromus catharticus Vahl. Prairie grass is found occasionally.

Bromus mollis L. Soft brome is also present.

Pholiurus incurvus (L.) Schinz & Thell. This grass lines the creek.

Juncus lampocarpus Ehr. This rush also edges the creek.

Ornithopus pinnatus (Mill.) Druce. Serradella, a legume, occurs frequently on the dunes.

Polycarpon tetraphyllum L. Allseed, a member of the Caryophyllaceae, forms mats on bare sand of fixed dunes.

Silene gallica L. Catchfly, another member of the Caryophyllaceae, is present.

Erigeron canadensis L. Canadian fleabane, a Composite, is common.

Hypochoeris radicata L. Catsear, another Composite, is also common.

Voucher specimens of the plants listed are preserved in the Museum Herbarium. Scientific names used are those of standard *Floras;* subsequent revisions, which are not widely known, have not been taken into account.

Mr Ogle, who has observed the three plants of *Ipomoea pes-caprae* since August 1966, has noted that they lose their leaves after storms. The resulting bare branches and new growth are shown in Plate 25, fig. b, and in Plate 26, fig. a. The woody rhizome of the largest plant, shown in Plate 26, fig. b, is about 5.5 cm. in diameter. The diameters of the central rhizomes of the second and third plants are 2.5 and 1.5 cm. respectively. Mr Ogle's observations on leaf fall suggest that growth is slow and erratic. The size of the woody rhizomes suggests that the plants have been present for a number of years. It is unlikely that they were planted by man; they are not garden flowers, crop plants, pasture plants or weeds. Possibly they grew from seed that was washed ashore from ocean currents which sweep around the north of New Zealand.

In the winter of 1956, Mr Brent and other farmers of the district noticed a number of tropical seeds and fruits on Ninety Mile Beach, and Miss Ruth Mason, Botany Division, D.S.I.R., Christchurch, listed them in

a paper entitled *Dispersal of Tropical Seeds by Ocean Currents,* published in Nature, 191 (4786): 408-9, July 22, 1961.

Mr R. C. Lloyd, District Forester, Kaikohe, found a seed among the plants in September-October 1966. Mr A. N. Sexton, Conservator of Forests, Auckland, also gathered a capsule at that time. Van Ooststroom described the capsule and seed of ssp. *brasiliensis*:—

"capsule globular, c. 12-15 mm. high, glabrous, 4-valved, 2-celled, 4-seeded; valves thick, brown outside, white inside; seeds black, densely brownish tomentose, 6-7 mm. long."

The capsule found by Mr Sexton is 16 mm. high, 4-valved, 1-celled, 1-seeded. Apparently one cell and three seeds have aborted. The seeds found by Messrs Lloyd and Sexton are both 8 mm. long.

H. N. Ridley, in *The Dispersal of Plants throughout the World,* L. Reeve & Co. Ltd., Kent, 1930, p. 302, mentions that many species of the Convolvulus family are widely sea-dispersed, and that buoyancy is often due to an unoccupied space in the testa or outer seed coat. Certainly both seeds from the Ninety Mile Beach plants float and roll like ping-pong balls on the surface of water.

The only flower obtained so far was gathered in January 1967. Van Ooststroom described the flower of ssp. *brasiliensis*:—

"exterior sepals 5-8, interior ones 6-11 mm. long, corolla 3-5 cm. long."

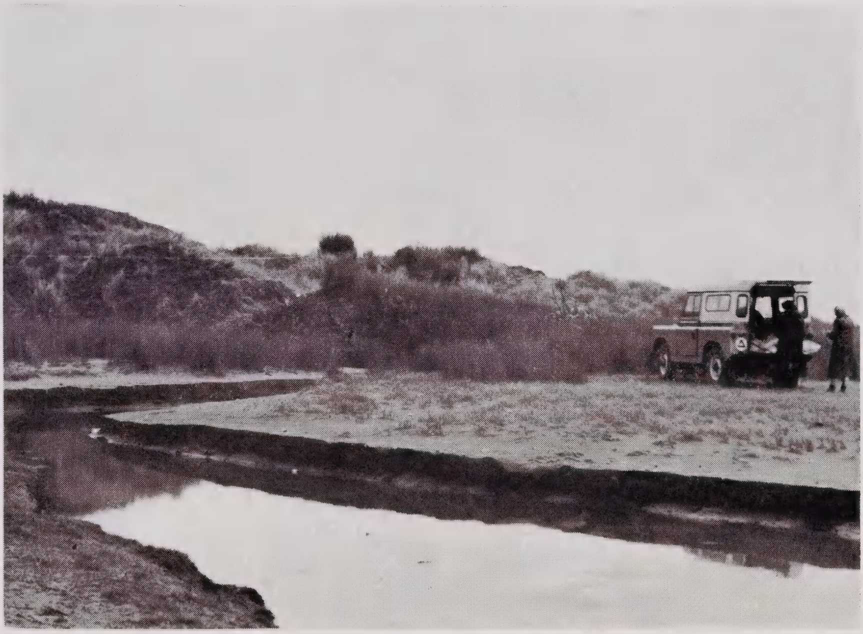
The measurements of the dried flower, gathered in January, are:— exterior sepals 10 mm., interior ones 12 mm., corolla 4.5 cm. long.

Clearly, further collections of flowers, fruit and seed, and further observations of the growth of the plants are desirable.

Recently, Mr and Mrs Brent advised that they have seen "at least two other seedlings at Hukatere, probably since destroyed by cattle", and a hunt for further plants in the dunes about Hukatere might also be worthwhile.

Acknowledgments

I am indebted to Mr A. N. Sexton for bringing this interesting find to the Museum; to Mr R. C. Lloyd for permission to use his excellent photographs; to Mr D. Ogle for invaluable help in the field; and to the Director, Botany Division, D.S.I.R., Lincoln, for supplying information for this note.



(Above)—Stream two miles north of Hukatere Lookout, Ninety Mile Beach. Two plants of *Ipomoea pes-caprae* grow on the dune behind the creek, with *Spinifex hirsutus* and other species. The Landrover is standing on a carpet of *Carex pumila* with a belt of *Leptocarpus simplex* behind. Photo R. Cooper

(Below)—Bare stems and new growth of *Ipomoea pes-caprae* in the *Spinifex-Leptocarpus* community. Photo R. Cooper

(Above)—New growth from a woody rhizome of *Ipomoea pes-caprae,* among *Spinifex hirsutus.* Photo R. C. Lloyd

(Below)—The central rhizome of the largest plant of *Ipomoea pes-caprae,* about 5 c.m. in diameter. Photo R. C. Lloyd

VEGETATION OF GREAT ISLAND, THREE KINGS GROUP, IN 1963

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ABSTRACT

New maps are presented for the quadrats established in 1946 when goats were exterminated on the island The composition of the canopy on the two forested quadrats is now changing, mainly through additions of *Melicytus ramiflorus* and *Meryta sinclairii.* A shrubbery of *Leptospermum ericoides* covers most of the quadrat that was laid down in grassland. Much of the island is less altered than the quadrats, so that *Leptospermum ericoides* still regenerates in some small forest windthrows, but there is widespread suppression of this and other arborescent species by the shrub *Coprosma rhamnoides* or by dense herbage.

In 1889 goats were liberated on Great Island, the largest of the Three Kings Islands. They perhaps joined a small herd surviving from the days of Maori settlement. Certainly they multiplied, and pressed so hard on the vegetation that by the 1930's the island's once rich and unique forest, which might in the course of almost a century since the departure of the Maoris have partially regained its character, was reduced instead almost entirely to kanuka (*Leptospermum ericoides*)[1]. At the plea of the staff of Auckland Museum, who have maintained a special interest in the group since Cheeseman made the first botanical exploration (Cheeseman, 1888), the goats were completely exterminated in 1946 by staff of the Wild Life Branch of the Department of Internal Affairs. E. G. Turbott, from the Museum, accompanied this party and took the opportunity to map three permanent quadrats so that recovery of the vegetation could be followed quantitatively (Turbott, 1948). Quadrat II was chosen as a fair sample of light forest of kanuka, and the other two as atypical extremes: quadrat I is in a moist valley in which a few representatives of the original mixed forest had survived, while quadrat III is exposed near a cliff top and was covered only with a sparse turf.

Auckland Museum mounted an expedition to the Three Kings in 1951 and devoted the December number of these Records to its findings. In the article there on Turbott's quadrats (Holdsworth, 1951), the hope was expressed that someone would be found to take a further census of the plant cover every five years. In fact plans were made to do so, but it was not until December 1963 when H.M.N.Z. Navy kindly placed the patrol launch "Paea" (Lt. Commander D. Davies, R.N.Z.N.) at the service of an expedition from Wildlife Branch of Internal Affairs, that these were realised—nearly 13 years since the last survey, and nearly 18 years since the goats were eliminated. As will appear, however, it is fortunately almost certain that no critical stage in the regeneration has been missed in the interval.

[1]Nomenclature follows the New Zealand floras of Allan (1961) for dicotyledons and ferns and of Cheeseman (1925) for monocotyledons, except where a reference is given.

General

Turbott intended Quadrat II to be a sample of the predominant vegetation of Great Island. So it still appeared to be in 1951, but it is becoming evident that it is transitional between the usually dry kanuka forest and the moister and richer valley forest below, typified by Quadrat I. It is unfortunate then, that we have not had a good sample of the ordinary forest under observation and the follwing impressions are intended to remedy the deficiency:—

From a distance, most of the forest looks very much as it did in 1951. Looking down from above, the kanuka canopy shows the same uniform cover and rather billowing texture that it did in 1946 (Baylis, 1948, fig. 5). Only locally are there variations, of which that provided by the pohutukawa (*Metrosideros excelsa*) grove is the most prominent because of extra height. It is not new, but it is extending, and seedlings in the adjacent bare or grassy areas (Baylis, 1951, figs. 4 and 5) have produced bushes that are now in flower. It is only in moister valleys, and on slopes with deep soil well fertilized by sea birds, that a new element appears in the canopy: a sprinkle of dark glossy crowns of puka *(Meryta sinclairii)* among the greyish green of the kanuka. Only very locally, e.g. immediately to the east and north of the isthmus, is the replacement of kanuka by puka anywhere near complete. Most of the kanuka, on the contrary, appears more vigorous than in 1951. In Quadrat II some standing trees were recorded as dead. But a limb or so must have retained an undetected tuft of foliage. In 1963 we marked old trees very much alive in some of these positions. It is still true, as it was in 1951, that kanuka is nowhere regenerating on Quadrats I and II, but we did, in the upper Tasman Va., for example, come across this species continuing to re-establish in small clearings where competition from other tree species or from vigorous herbage was lacking. But the appearance of rejuvenescence elsewhere is due mainly to increased leafiness of the old trees. The goats did not directly interfere with their crowns or bark, but it is likely that the ageing trees have responded to the absence of trampling, a general closing of the plant cover, and perhaps, an increased return of nutrients by an enlarged gull population.

Below the kanuka canopy, change is everywhere evident. Over most of the eastern plateau and on the ridge between the Tasman and Castaway Valleys the spaces between the kanuka trunks have filled with an almost impenetrable thicket of divaricating *Coprosma rhamnoides.* The light sandy soil of the eastern plateau (Battey, 1951, pl. 9) seems hostile to woody species other than manuka *(Leptospermum scoparium),* kanuka, *Coprosma rhamnoides,* and the occasional mingimingi (*Cyathodes fasciculatus*). The undershrubs prevent regeneration of *Leptospermum,* and their own dense but lower canopy is here and there emerging to survive full exposure. In the areas where *C. rhamnoides* is less aggressive, young cabbage trees *(Cordyline kaspar),* puka and Three Kings coprosma *(Coprosma macrocarpa)* are widespread but only locally abundant. The steepest and shallowest soils appear to have deteriorated under kanuka so that their fertility and water retaining capacity are unfavourable for other trees.

Where the density of woody plants has increased, the development of ground cover has been checked, but on gentle slopes, valleys, and hollows with deep soil, herbs so luxuriate as to have a reverse effect. The sedges, *Scirpus nodosus, Carex virgata* and *C. testacea* are still the most

important generally, but *Dianella intermedia* is often conspicuous. *Pratia (Colensoa) physaloides,* on the other hand, has declined since 1951, and good banks of it are now only to be found at its original stations along the Tasman Stream. Ferns, especially *Blechnum capense,* are plentiful in the lower Tasman Valley and, along with the preceding species, they are excluding tree seedlings from openings in the ancient kanuka canopy. This is so generally true that it is still not possible to predict the composition of the new forest that will eventually fill the Tasman Valley.

On the whole, there has been no radical qualitative change in the composition of the island's plant cover in the 13 years since the last survey. Quantitative adjustments between the species have undoubtedly occurred, but these we can only comprehend on the Quadrats.

Finding the Quadrats

Turbott anticipated that it would become more and more difficult to find the plots as the forest recovered, and was careful to leave (1948) detailed directions for locating them from prominent landmarks. In 1951, even with Turbott himself there to help, it was not easy to find the corner pegs. On Quadrat I there was no longer a clear line of sight for more than a few yards, and through difficulty in keeping the boundaries straight, errors were undoubtedly introduced. Accordingly, the corners have now been re-marked with 5-foot aluminium posts banded with orange paint. White p.v.c. circles have, in addition, been nailed to all the prominent trees close to, but within, the boundaries. These markers are at shoulder height and face outwards.

Turbott used a prominent rock as a first direction to the valley in which Quadrats I and II both lie. This is still visible from the top of the isthmus between the landing beaches, but can no longer be kept in view after one leaves the saddle. There are similar rocks on the same face, so it is easy to be led wide of the quadrats by travelling on the bearing he gives, but from the wrong rock. We have now marked the proper rock with a white p.v.c. *hexagon* facing the saddle. Even when the rock has been reached, it is difficult to keep a straight course through the undergrowth, and we had particular trouble in finding Quadrat II. So we have laid a trail of these hexagon markers from the first tree across the saddle, to Quadrat I, and thence to Quadrat II. The approach is not direct but attempts to keep an easy grade, curving down the right side of the saddle ridge, skirting the base of the line of rocks and so to the SW. corner of Quadrat I. The post at this corner is numbered "1" and is shown on the top left hand corner in Turbott's and our charts. The line of p.v.c. circles to the left should then be followed to corner post "2" (NW. corner, top right of charts) and from there the hexagons continue over some rocks, more or less straight to post "8" (S. corner, bottom left of charts) of Quadrat II.

On reaching the vicinity, one can still easily recognise the country and find the marker rock near Quadrat III; but the rock above Castaway Valley from which Turbott gave directions for crossing the island is no longer visible and it is therefore difficult to strike the saddle between Castaway and Tasman Valleys. So we also intended to define a trail between the two valleys to Quadrat III; but only the first 100 yards or so from the Depot were laid. A fourth line of hexagons leads to the specimen of *Plectomirtha*

baylisiana, but this only begins at the edge of the cliff about the position of the encircled "2" on the map published by Baylis (1948 p. 242).

The Quadrats

Methods

As in 1951, each of the quadrats was divided by a grid of strings and the position of plants mapped by eye within the squares so formed. These were 2 metres each way on Quadrat I and 1 metre on the smaller ones. With two workers, it was easier this time to keep the strings straight where thickets blocked the line of sight. Even so, on the boundaries, the inclusion of some marginal trees had to be arbitrarily decided, and we have at times departed from both Turbott's and Holdsworth's previous boundaries. Except for some doubt along the SE. boundary of Quadrat II, however, we have been able to reconcile our records with those of Holdsworth by identifying the individual trees. The side lines should, from now on, be stabilised by the plastic markers.

On Quadrat I we recorded individual plants, even of herbs when they were discrete; but on Quadrat II where the ground cover is more evenly mixed, and on Quadrat III where most are annuals, we have usually only indicated absence or presence of the herb species in each square. On Quadrats I and II, the girth of trunks over one inch diameter was measured (at breast height) if the specimen was one established since 1946.

Quadrat I, the Canopy (Plate 27)

Holdsworth's chart of this plot in 1951 shows a canopy of 81 trees (erroneously stated as 80 in the text), with kanuka contributing most of the cover. An equal number of cabbage trees was involved but their tufted crowns made them relatively unimportant. Smaller numbers of *Melicope, Litsea, Paratrophis* and one each of *Melicytus* and *Pittosporum* made up the total. These were all old trees, the same as appear in Turbott's chart for 1946, except for sixteen kanukas which had died in the interim. We now show these originals further reduced to 62, mainly through the death of another eleven kanuka (Table 1). However, the canopy has now been reinforced by young trees, none of which was considered of canopy rank in 1951. By far the most numerous are *Melicytus*, equal in number by themselves to the whole complement of canopy trees in 1951, but not yet contributing more than 29% of the basal area of the new tree trunks (Table 3). Next, though only half as numerous, are kanuka. Unlike the *Melicytus* these are not new seedlings since 1946 but the survivors of competition within the two thickets shown by Turbott along the NE. boundary. *Entelea*, although next on the list in Table 1, is presumably of no permanent importance. Already more than one generation of this ephemeral tree has been completed since 1946, judging by the dead specimens on the plot, and the published record of a life span of 6-9 years (Millener, 1947). The only other tree calling for comment is *Meryta*, with 15 crowns now in the canopy, contributing 13% of the basal area (Table 3).

Quadrat I, the Undergrowth (Plates 28 and 29)

Among the younger trees, we recorded specimens under 15 cms as seedlings. These are not tabled separately because they were few and most (i.e. 28) were *Paratrophis*. Of these none except the group in the N. corner

may actually have come from seed, for like other figs this shrub suckers freely. The rarity of new seedlings indicates a great reduction in regeneration on this plot, for we recall that seedlings were abundant in 1951, and the size distribution of woody plants then tailed off the other way. There can be little doubt that the deep shade now cast, for which the new *Melicytus* canopy is mostly responsible, has practically stopped colonisation.

The most numerous saplings are again *Melicytus*, with *Litsea* and *Melicope* next, but far behind (Table 1). In comparing "under canopy" totals for 1951 and 1963 saplings attaining the canopy in this interval (bracketed) must be taken into account. A contrast between *Leptospermum* and *Meryta* is then apparent. About half the *Leptospermum* are now trees, and most of the rest have been eliminated. All the *Meryta* saplings are now trees, but a new generation maintains its numbers in the understory. *Coprosma rhamnoides*, so abundant in adjacent parts of the island, has almost exactly the same representation as in 1951.

Quadrat I, Lianes Clematis is mainly confined to the clumps marked by Turbott. *Tetrapathaea* and *Muehlenbeckia*, on the other hand, have greatly increased their territories, contributing both to the canopy and, in the two open spaces, to the ground cover.

Quadrat I, Herbs The variety of herbs is considerably greater than in 1951, when not more than a dozen or so species were represented.* Now we have 21 listed in the key to Plate 29. None of these new arrivals gives rise to much surprise, however. They have all been recorded previously from some part of Great Island (Baylis, 1958) except *Asplenium lucidum*. Even that is known from the smaller islands. Although so many more species are represented, the density of ground cover overall has decreased since 1951. The whole of the W. quarter is substantially bare underfoot. The extensive areas of almost pure sedge in the S. quarter and NE. half are still noticeable, but obviously diminished in extent. The solid banks of *Pratia (Colensoa)* along the water-courses are much reduced in width, and noticeably in purity.

Quadrat II (Plates 30 and 31)

It was said of Quadrat II in 1951 that, superficially, little change had occurred in the general appearance. We have to record the opposite now; it has changed beyond recognition, mainly because of the rampant growth of passion vine, only three plants of which were recorded in 1951. *Clematis* which does not appear to have spread on Quadrat I has, all the same, spread to Quadrat II and these lianes together with *Meryta* give the impression that this site is damper and lusher than we had supposed. Indeed, it looks today not unlike parts of Quadrat I in 1951.

Of the twenty old kanuka providing the canopy in 1951, thirteen are still alive including three apparently raised from the dead, as earlier mentioned (Table 2). Six young kanukas have now also added their crowns to the canopy, and with seven smaller ones account for the young kanukas present in 1951. The single old cabbage tree is still there, but appears to have lost its original crown and regrown from the base. It has now been

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* The *Haloragis* indicated in Fig. 19 (1951) was actually *H. erecta*.

joined in the canopy by no less than twenty-three new ones. These cabbage trees are the most obvious additions (Plate 34b), but the nine *Meryta* may prove in the long run more significant. The single canopy specimens of *Paratrophis* and *Melicytus* are also worthy of mention because they too are new arrivals since the extinction of the goats.

Of the woody plants which do not yet reach into the canopy, the most noticeable is *Coprosma rhamnoides* of which we counted a total of 166, double that present in 1951. But it is less dense than it becomes on the sandy soil not far distant and it is disguised by an overgrowth of vines (Plate 33a, b). *Paratrophis* and *Litsea* were recorded in 1951, undoubtedly derived from parents down the valley. Only one of the former and two of the latter have survived, but they have now been joined by *Pittosporum* and *Geniostoma*. The single seedling of *Melicope* that Turbott saw at the time the goats were shot, is still alone and has grown to a height of three feet in the eighteen years intervening.

In the ground cover there are fewer significant changes to record. Practically the whole area, except for patches in the deepest shade, is still closely covered with sedge and, as before, these are everywhere pervaded with the fern *Doodia media*. The single plant of *Davallia tasmani* has disappeared, but *Athropodium* which also was in 1951 represented by one plant, now has some half dozen distributed in the north quarter. *Erigeron* and *Haloragis* were not recorded this time but *Asplenium lucidum, Pteris comans, Scirpus nodosus, Poa anceps* and *Pratia physaloides* have come in and may be expected to be more permanent.

Quadrat III (Plate 32)

As shown in the superscription, the diagram of this plot is rotated 90° from the corresponding charts in Turbott and in Holdsworth, 1951. This makes the slope of the land lie down the page as with the other two quadrats.

The area in which this plot lies appears not much changed since 1951. However, low growing kanuka, which had only just reached the plot then, has been steadily creeping up the slope, becoming confluent on the quadrat and leaving little open ground. It does not provide an even cover as might be assumed from the diagram, but has a lumpy appearance, seemingly composed of a mosaic of two genetically distinct types: one trailing, and the other making erect rounded bushes (Plate 35a). The tallest of the latter measured about a metre.

The closing up of the kanuka has meant a considerable reduction in the number of other species present, for the ground beneath is usually bare (Table 4). It is evident, however, that its shade does not exclude *Scirpus nodosus* which has indeed increased since 1951, or *Coprosma rhamnoides,* which unrecorded then, now has 89 plants within the quadrat, mostly well beyond the seedling age. Indeed, it is very probable that this *Coprosma* requires the kanuka as a nurse, for it is absent from the uphill third of the quadrat which the kanuka has only recently covered (Plate 31). There is also a progression downhill in size of *Coprosma*. None is emergent (the tallest measured 80 cm.) and it would appear that this area is reproducing in miniature the association of the drier parts of the island: kanuka forest with *Coprosma* as an understory, and almost bare ground beneath. In one patch close to an open space there is a ground cover of

Carex testacea, again just as on the island generally. Two other elements, *Cordyline* and *Melicope*, which have appeared since 1951 may initiate a radical change in this part of the island. As yet, they are battered isolated specimens but the *Cordyline* is already flowering.

In the previous account of this quadrat (Holdsworth, 1951) a table was given of the frequency of herbs in the grassy sward, based on their presence in the 15 squares along the SW. boundary which were all that could then be completed. In 1963 we made observations for all squares but the majority of them, of course, have no sward in them and Table 4 includes an analysis of those 15 grassy squares nearest to the SW. side, with 1951 figures for comparison. A suggestion here, that what is left of the sward is poorer in species than it used to be, is confirmed in the list (Col. B) for the whole quadrat, from which *Sonchus oleraceus, Oxalis corniculata, Cotula australis, Dichondra repens, Hydrocotyle novae-zelandiae* and *Zoysia matrella* are missing. The last name is particularly noteworthy because Turbott originally designated the plot as an area of "typical *Zoysia* sward". It will be noticed, in compensation, that Table 4 takes in a number of new perennials, and it is satisfactory to record that alien plants in the vegetation are diminishing as a consequence of the elimination of the alien animals.

Conclusions and Forecasts

Our previous projections of the course of development of stable vegetation on Great Island have changed somewhat. When knowledge of the smaller islands was still superficial, Baylis (1948) assumed that the vegetation of Great Island alone had been seriously modified. As two distinct types of forest could be seen on the smaller ones, it followed that the largest island must also have supported both types in its virgin state. The two types seemed to show zonation: a coastal zone of *Meryta* forest and an inland zone of mixed forest with a rich flora including most of the endemics. By 1951, however, it seemed unlikely that *Meryta* forest was permanent, even close to the sea. Evidence for Maori occupation of both the SW. and NE. Islands was accumulating, and in 1958 Baylis stated that "there is nothing to support (my original) opinion that puka was permanently dominant on the seaward margin (of Great Island)". On the SW. island where the most extensive pure *Meryta* forest is to be seen, its regeneration is tardy and dependent on the appearance of a considerable canopy gap, although the seedlings are tolerant of the shade of kanuka on Great Island. Where trees of karaka (*Corynocarpus laevigata*) or parapara (*Heimerliodendron brunonianum*) occur, their seedlings establish before these gaps develop and usurp the place of *Meryta*, a process which, however slow, must ultimately eliminate it as a canopy tree. Baylis (1958) also suggested that pohutukawa (*Metrosideros excelsa*) might be a permanent dominant on steep or rocky sites where its limbs could sag to the ground and root again so that each tree is potentially immortal.

There is a small grove of pohutukawa on Great Island and it is rapidly spreading on to Bald Hill but the circumstances are unusual in that the ground was quite open and mainly broken rock. We have no record of pohutukawa appearing on any of the quadrats and it is not expected except on the bare ground remaining in Quadrat 3. As the general vegetation of Great Island, pohutukawa forest does not now seem a possibility. The species is plainly strongly light demanding throughout its life, and the

situation in parts of South-West Id. where puka grows beneath a pohutukawa canopy must result from the invasion of pohutukawa forest by a puka understory. This is now occurring in the old grove on Great Island (Plate 35b).

The spread of puka over South-West Id. was favoured by a fertile soil (Baylis, 1958). In Great Id. it is not being so generally encouraged. But we hesitate to predict any permanence for the relatively small species that are for the time being excluding tree seedlings, notably *Coprosma rhamnoides* on the drier soils particularly on the eastern limb of the island, and the dense growth of sedge and fern in windthrows in the Tasman Valley. Yet some of the species which owe their chance to dominate to the sudden end of goat browsing may prove unexpectedly persistent, like the patch of bracken on North-East Id. (Baylis, 1958).

TABLE 1:

Quadrat 1. Numbers of woody plants. Canopy trees are all survivors of the 1946 canopy except those enumerated in brackets under 1963. Nearly all plants recorded under the canopy in 1963 exceed 30 cm in height.

	IN CANOPY				UNDER CANOPY		
WOODY SPECIES:	1963		1951	1946	1963	1951	1946
Brachyglottis arborescens		(1)				2	
Coprosma repens					2		
Coprosma rhamnoides					30	27	9
Cordyline kaspar	28		34*	29	9	7	
Entelea arborescens		(20)			8	3	
Geniostoma ligustrifolium		(3)			17	3	
Hiemerliodendron brunonianum					3		
Leptospermum ericoides	23	(39)	34	50	7	73	43
Litsea calicaris	4	(1)	4	4	75	52	?
Melicope ternata	4	(5)	5	5	39	51	15
Melicytus ramiflorus	1	(81)	1	1	210	238	
Meryta sinclairii		(15)			16	15	
Myoporum laetum					2	5	7
Paratrophis smithii	1	(2)	2		46	5	
Pittosporum fairchildii	1		1		16	4	
TOTALS	62	(167)	81	89	480	485	74

* probably the original 29 plus 5 not previously included within boundaries of plot.

TABLE 2:

Quadrat 2. Numbers of woody plants. Canopy trees are all survivors of the 1946 canopy except those enumerated in brackets under 1963. Nearly all plants recorded under the canopy in 1963 exceed 30 cm in height.

p—present but not counted.

	IN CANOPY				UNDER CANOPY		
WOODY SPECIES	1963		1951	1946	1963	1951	1946
Coprosma rhamnoides					166	75	p
Cordyline kaspar	1	(23)	1	1	5	17	
Geniostoma ligustrifolium					1		
Leptospermum ericoides	13	(6)	20	46	7	12	
Litsea calicaris					2	4	
Melicope ternata					1	1	1
Melicytus ramiflorus		(1)				2	
Meryta sinclairii		(9)			3	8	
Myoporum laetum						1	
Paratrophis smithii		(1)				3	
Pittosporum fairchildii					2		
TOTALS	14	(40)	21	47	187	123	1

TABLE 3:

Quadrats 1 and 2, Dec., 1963. Total basal area* contributed by canopy trees first recorded in 1963, excluding any below 2.5 cm. diam. The figure in brackets is the percentage of the total.

	BASAL AREA CM^2			
SPECIES	Quadrat 1		Quadrat 2	
Brachyglottis arborescens	266	(3)		
Cordyline kaspar			356	(38)
Entelea arborescens	1334	(14)		
Geniostoma ligustrifolium	178	(2)		
Leptospermum ericoides	3488	(37)	307	(33)
Melicope ternata	206	(2)		
Melicytus ramiflorus	2693	(29)	79	(9)
Meryta sinclairii	1193	(13)	182	(20)
Paratrophis smithii	54	(<1)		
TOTALS	9412	(100)	924	(100)

* Area of trunk cross section at breast height (1.4m.).

TABLE 4:

Quadrat 3—herbs. Number of metre squares on which each species was present in 1963:

A—for the 15 grassy squares nearest the SW boundary, with figures for 1951 in brackets.

B—for all 225 squares.

SPECIES	A.		B.
Adianthum hispidum			12
Agropyrum kirkii Zotov	6	(0)	32
Aira caryophyllea L.	10	(10)	33
Aira praecox L.		(8)	2
Carex breviculmis	11	(1)	42
Carex testacea			97
Centella uniflora	5	(15)	39
Chloris truncata R. Br.			2
Cirsium vulgare (Savi) Ten.	1	(0)	5
Cotula australis		(1)	
Cyathodes fraseri	2	(0)	17
Davallia tasmani			3
Deyeuxia crinita	6	(15)	83
Dianella intermedia			3
Dichondra repens		(1)	
Doodia media		(1)	50
Echinopogon ovatus			6
Erigeron canadensis L.		(1)	6
Gnaphalium collinum Lab.	15	(8)	71
Haloragis erecta			2
Hydrocotyle novae-zelandiae		(1)	
Hypochoeris radicata Lab.	15	(5)	96
Microlaena stipoides			1
Moss	2	(0)	25
Notodanthonia sp.	11	(5)	89
Oplismenus undulatifolius			12
Oxalis corniculata		(3)	
Phormium tenax			1
Pteris macilenta			1
Scirpus nodosus	5	(0)	123
Sonchus oleraceus L.		(6)	
Thelymitra longifolia			1
Vulpia dertonensis (All.) Volk.	1	(10)	31
Wahlenbergia gracilis	3	(9)	11
Zoysia matrella		(3)	
TOTAL SPECIES	14	(18)	29

TABLE 5:

Quadrat III, Dec., 1963. Numbers of plants of *Coprosma rhamnoides* in strips 1 meter wide across the plot, arranged in order down the slope.

Strip	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Seedlings	—	—	—	1	1	7	9	3	11	2	—	—	2	—	—
Older Plants	—	—	1	—	—	—	—	—	1	16	19	4	7	2	3

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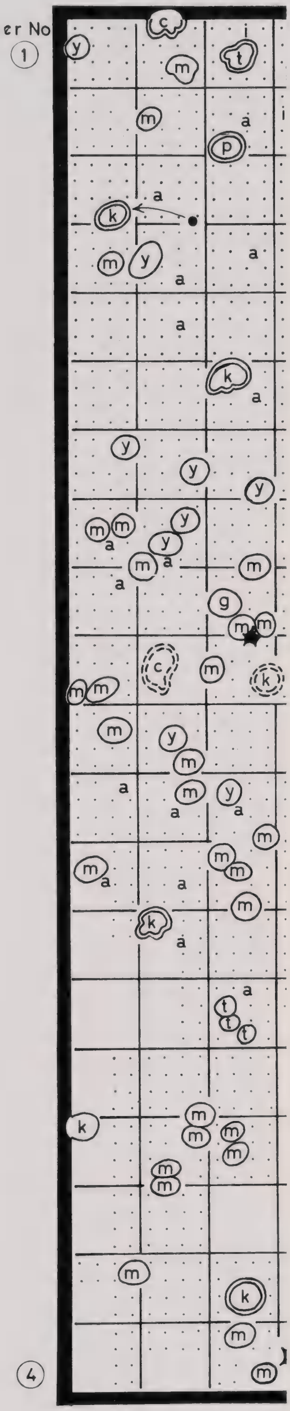

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TABLE 5:

Quadrat III, Dec., 1963. Numbers of plants of *Coprosma rhamnoides* in strips 1 meter wide across the plot, arranged in order down the slope.

Strip	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Seedlings	—	—	—	1	1	7	9	3	11	2	—	—	2	—	—
Older Plants	—	—	1	—	—	—	—	—	1	16	19	4	7	2	3

REFERENCES

BATTEY, M. H., 1951. Notes to Accompany a Topographical Map and a Provisional Geological Map of Great Island, Three Kings Group, Rec. Auck. Inst. Mus., 4, 93-98.

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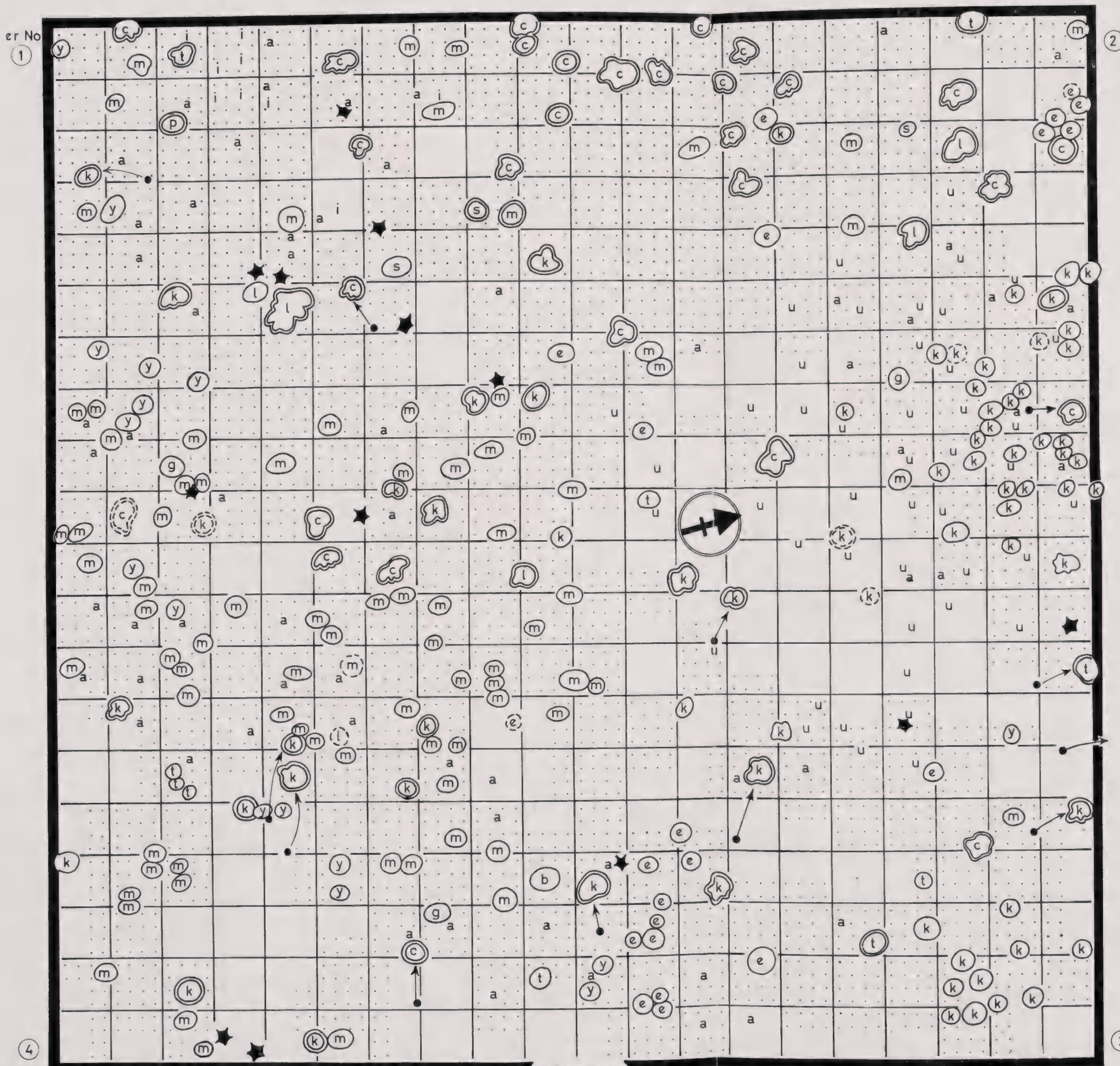
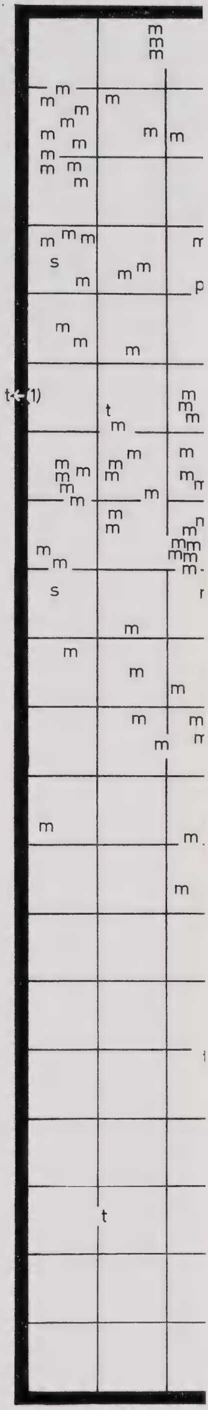


Quadrat I — canopy, 1963. Unstippled areas have no canopy. Original canopy trees indicated by double lines, trees entering canopy since 1951 by single lines, dead standing trunks by broken lines. Stars show sites from which a tree has disappeared since 1951. Arrows reconcile positions with those on 1951 map.

a. *Tetrapathaea tetrandra;* b. *Brachyglottis arborescens;* c. *Cordyline kaspar;* e. *Entelea arborescens;* g. *Geniostoma ligustrifolium;* i. *Clematis paniculata;* k. *Leptospermum ericoides;* l. *Litsea calicaris;* m. *Melicytus ramikorus;* p. *Pittosporum fairchildii;* t. *Melicope ternata;* m. *Muehlenbeckia australis;* y. *Meryta sinclairii.*



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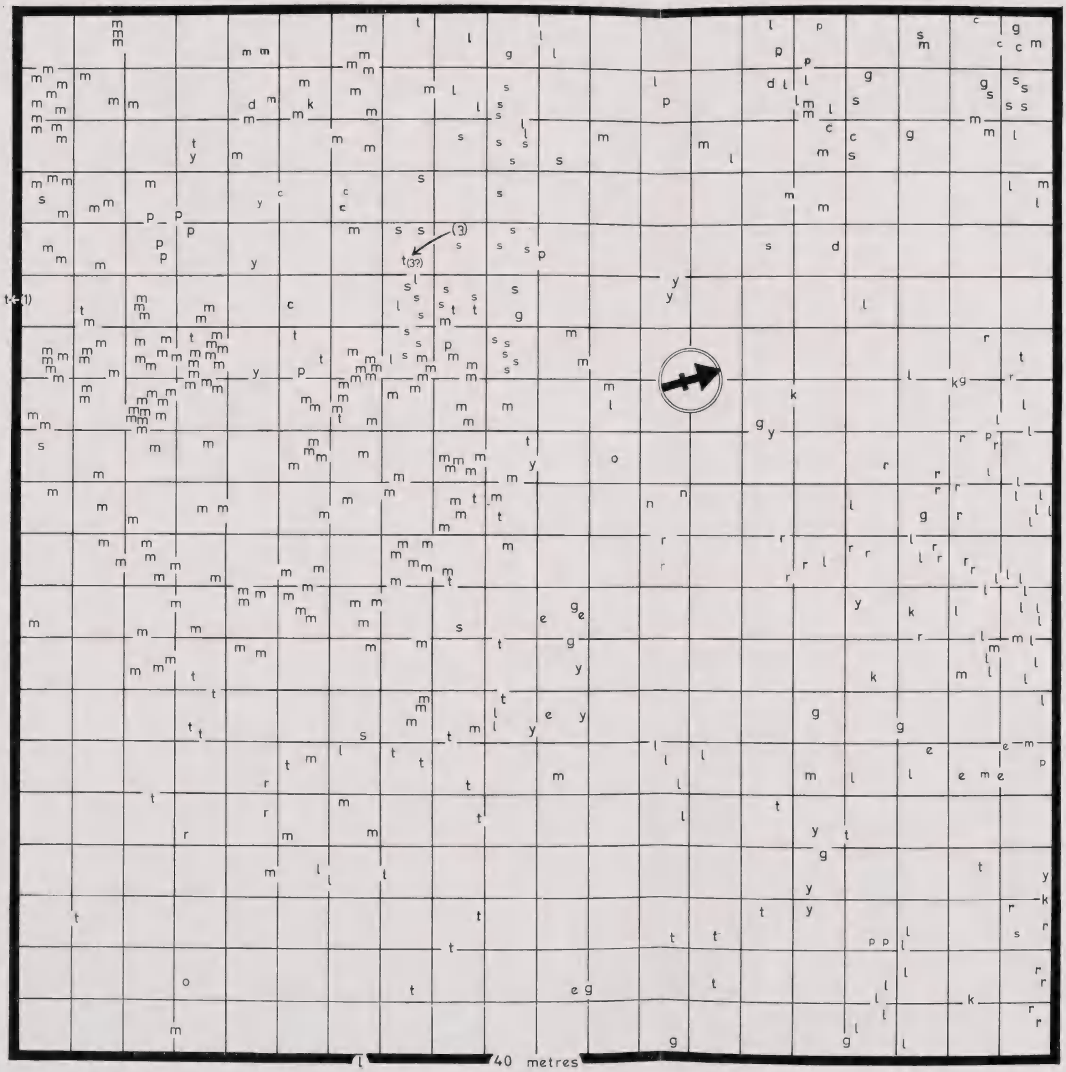
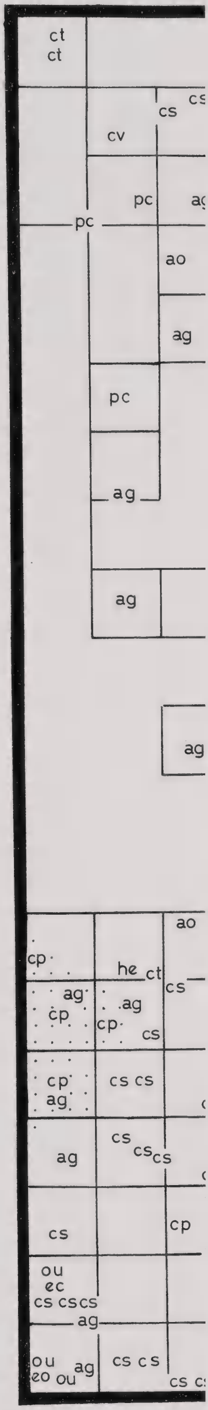


Quadrat I—young trees and seedlings (mostly exceeding 30 cm high), 1963. (1) and (3) are seedlings marked by Turbott (1947).

c. *Cordyline kaspar;* d. *Hiemerliodendron brunonianum;* e. *Entelea arborescens;* g. *Geniostoma ligustrifolium;* k. *Leptospermum ericoides;* l. *Litsea calicaris;* m. *Melicytus ramiflorus;* n. *Myoporum laetum;* o. *Coprosma repens;* p. *Pittosporum fairchildii;* r. *Coprosma rhamnoides;* s. *Paratrophis smithii;* t. *Melicope ternata;* y. *Meryta sinclairii.*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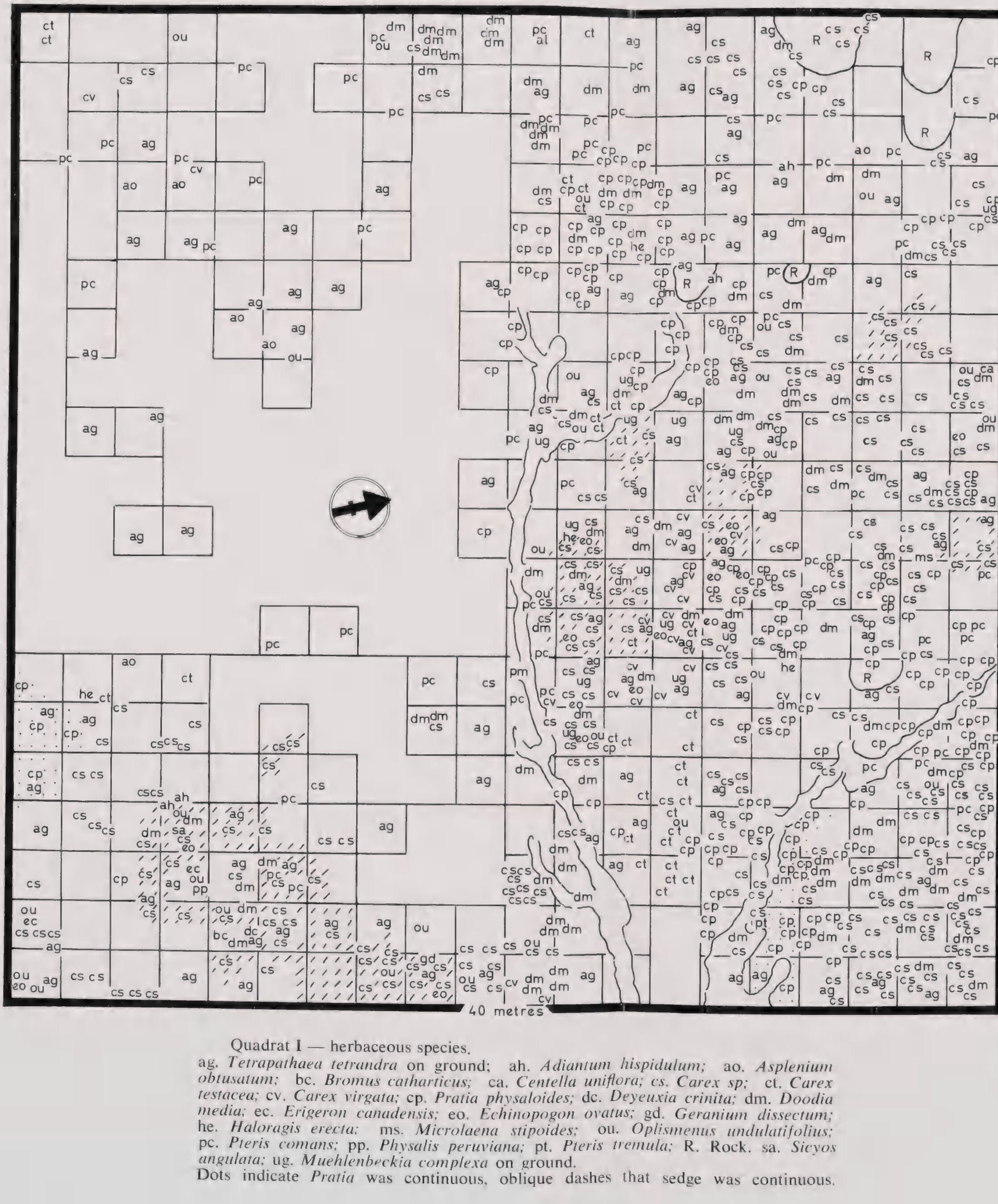
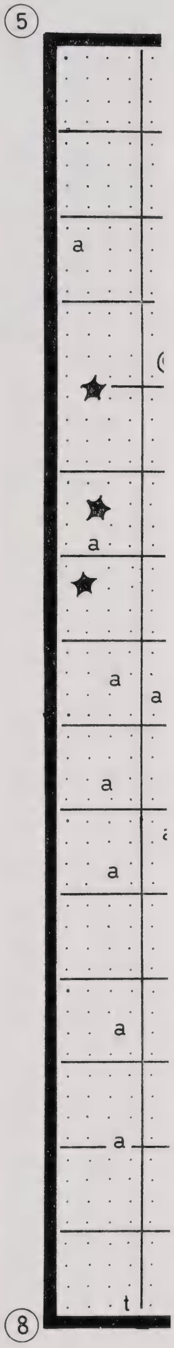


Quadrat I — herbaceous species.
ag. *Tetrapathaea tetrandra* on ground; ah. *Adiantum hispidulum;* ao. *Asplenium obtusatum;* bc. *Bromus catharticus;* ca. *Centella uniflora;* cs. *Carex sp;* ct. *Carex testacea;* cv. *Carex virgata;* cp. *Pratia physaloides;* dc. *Deyeuxia crinita;* dm. *Doodia media;* ec. *Erigeron canadensis;* eo. *Echinopogon ovatus;* gd. *Geranium dissectum;* he. *Haloragis erecta:* ms. *Microlaena stipoides;* ou. *Oplismenus undulatifolius;* pc. *Pteris comans;* pp. *Physalis peruviana;* pt. *Pteris tremula;* R. Rock. sa. *Sicyos angulata;* ug. *Muehlenbeckia complexa* on ground.
Dots indicate *Pratia* was continuous, oblique dashes that sedge was continuous.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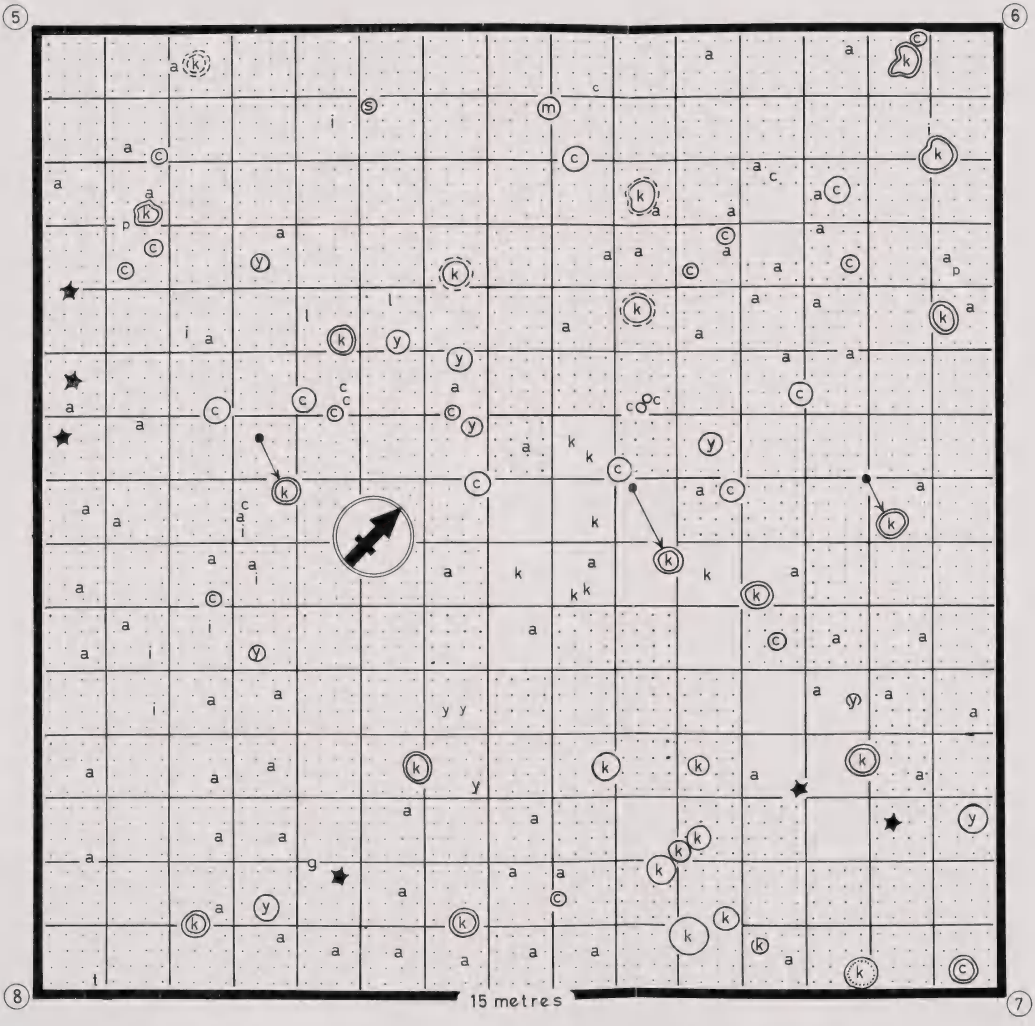
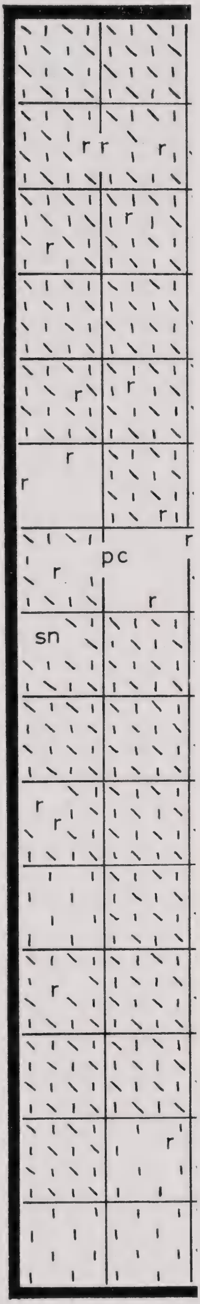


Quadrat II — trees and lianes both in and below canopy and the extent of canopy cover (stippled). Stars indicate sites of trees that have disappeared since 1951. Continuous double outlines indicate trees also recorded in 1951. Broken outer outlines indicate trees wrongly recorded as dead in 1951. Broken double outline indicates tree recently dead. Dotted inner outline indicates tree not included by boundary in 1951. No outline indicates seedling below canopy.

a. *Tetrapathaea tetrandra;* c. *Cordyline kaspar;* g. *Geniostoma ligustrifolium;* i. *Clematis paniculata;* k. *Leptospermum ericoides;* l. *Litsea calicaris;* m. *Melicytus ramiflorus;* p. *Pittosporum fairchildii;* s. *Paratrophis smithii;* t. *Melicope ternata;* y. *Meryta sinclairii.*



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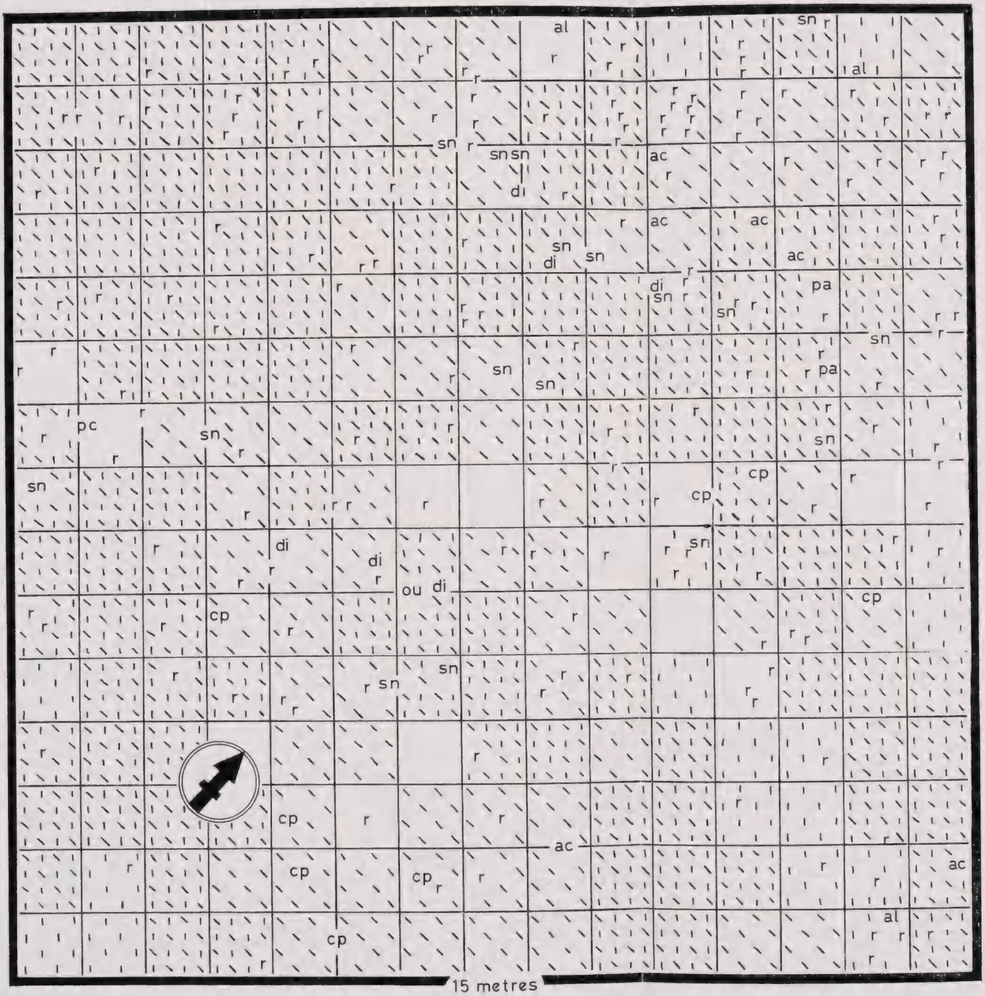
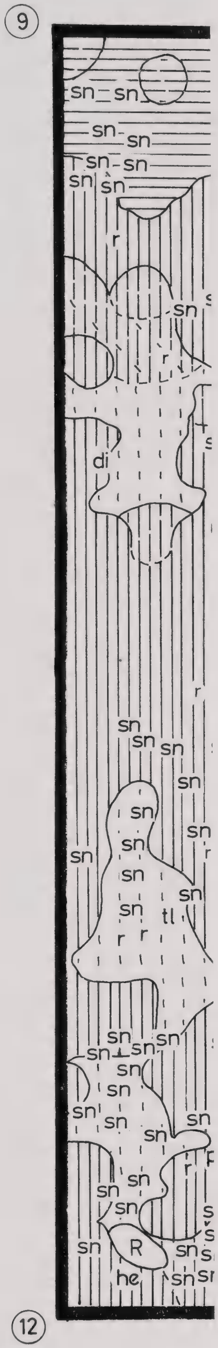


Quadrat II — undershrubs and ground cover. Squares with vertical dashes contain *Doodia media*. Squares with oblique dashes contain *Carex testacea*.
ac. *Arthopodium cirrhatum;* al. *Asplenium lucidum;* cp. *Pratia physaloides;* di. *Dianella intermedia;* pa. *Poa anceps;* pc. *Pteris comans;* r. *Coprosma rhamnoides;* sn. *Scirpus nodosus.*



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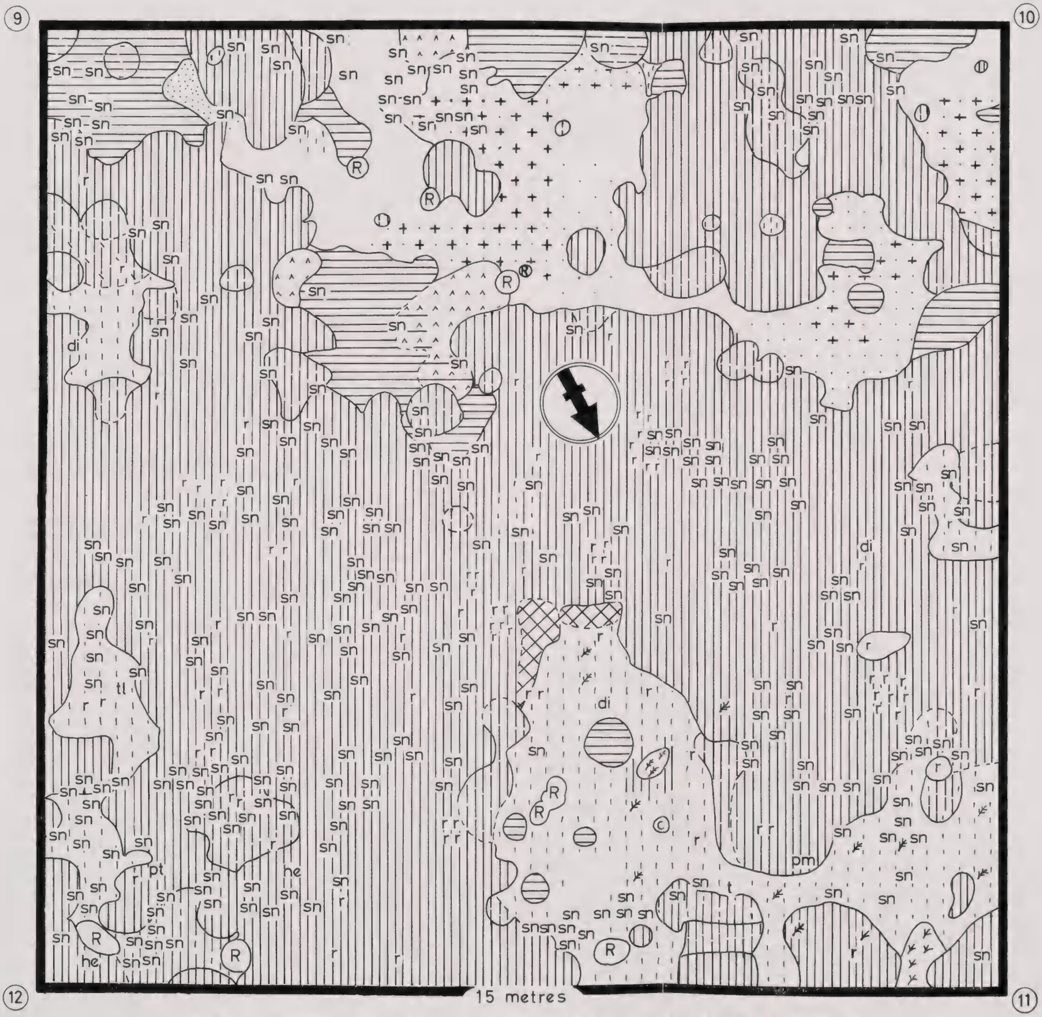


Quadrat III rotated 90° from orientation in Holdsworth (1951) and Turbott (1948): Bars indicate *Leptospermum ericoides* — vertical where it is erect; horizontal where prostrate; interrupted where moribund; diagonal where it is dead. Vertical dashes indicate grass. Oblique dashes indicate sedge *(Carex testacea)*. Dots indicate lichens and moss. Crosses indicate *Gnaphalium collinum*. Oblique crosses indicate *Davallia tasmani*. Oblique double-barred crosses indicate *Adiantum hispidum*. Inverted Vs indicate *Cyathodes fraseri*.

c. *Cordyline kaspar;* di. *Dianella intermedia;* he. *Haloragis erecta;* pm. *Pteris macilenta;* pt. *Phormium tenax;* R. bare rock; r. *Coprosma rhamnoides;* sn. *Scirpus nodosus;* t. *Melicope ternata;* tl *Thelymitra longifolia.*

a, Quadrat II, Dec. 1963. View towards peg 6 - cf. Turbott (1948) fig. 9; Holdsworth (1951) fig. 13.

b, Quadrat II, Dec. 1963 - cf. Turbott (1948) fig. 10; Holdsworth (1951) fig. 14.

a, Quadrat II, Dec. 1963 - cf. Turbott (1948) fig. 11.

b, Quadrat II, Dec. 1963. Diagonal view of canopy from near peg 6.

a, Quadrat III, Dec. 1963 - cf. Turbott (1948) fig. 14; Holdsworth (1951) fig. 16.

b, Inside the pohutukawa grove, Dec. 1963; showing *Meryta sinclairii, Cordyline kaspar* and *Cortaderia fulvida*. There was no understory in 1948.

NEW ZEALAND MOLLUSCAN SYSTEMATICS WITH DESCRIPTIONS OF NEW SPECIES; PART 6

By A. W. B. POWELL, Auckland Museum.

ABSTRACT

In this part twelve species are added to the New Zealand Recent fauna, and of these, three are new species, and ten are representative of genera not previously known in this faunal area—they are *Casmaria, Dolabrifera, Fusinus, Liniaxis, Lyncina, Morula, Proxicharonia, Pteropurpura, Semele* and *Tutufa.* All of the new additions are of tropical or subtropical origin, an element that has been greatly strengthened within recent years, largely due to the increased activity of skin divers, working in the previously unexplored depths of the off shore rocky areas. Regarding origins, the influence of the East Australian Current satisfactory accounts for the genera *Dolabrifera, Fusinus* and *Liniaxis.* There is a recent survivor from a characteristic New Zealand Miocene genus in *Proxicharonia palmeri n.sp.* The remaining genera, however, point to a tropical South Pacific origin, except for the *Pteropurpura,* which comes from Japanese seas. The most unexpected addition is *Lyncina vitellus,* the second species of a true cowry to the found living in New Zealand waters. The first true cowry to be found here, *Erosaria cernica tomlini* Schilder, 1930, was recorded in these records in 1965 (Powell, Rec. Auck. Inst. Mus., vol. 6, no. 2, pp. 164-165).

Family CYPRAEIDAE

Genus **Lyncina** Troschel, 1863.

Type: (s.d., Tryon, 1883) *Cypraea lynx* Linnaeus, 1758.

Lyncina vitellus (Linnaeus, 1758). Plate 36, Figs. 1-3.

1758 Cypraea vitellus Linnaeus, Syst. Nat. ed. 10, p. 721.

A second species of a true cypraeid can now be added to the New Zealand Recent fauna on the basis of one live-taken and three well-preserved empty shells of this common Indo-Pacific shell, obtained by members of the Whangarei group of skin-divers.

The living example was found crawling on a rock face, at night, at 90 feet, in Shag Bay, west coast of Tawhiti Rahi, Poor Knights Islands, and the dead shells were taken in the same area, at 100 feet, by Mr W. Palmer, who has the live-taken and the 59 mm. specimen in his collection.

Length 59.0 mm.; width 40.0 mm.; height 32.5 mm. (largest Poor Knights spec.).

Length 54.5 mm.; width 36.0 mm.; height 31 mm. (living Poor Knights spec.).

The nearest occurrence of this shell to New Zealand is the Sydney Harbour *M. vitellus orcina* Iredale, 1931, which is a stumpy more pyriform race. Typical *vitellus* is common in Queensland waters and in the islands of the South West Pacific.

Family NATICIDAE

Genus **POLINICES** Montfort, 1810.

Type: (o.d.) *Polinices albus* Montfort, 1810 = *Nerita mammilla Linnaeus, 1758.*

Polinices tawhitirahia Powell, 1965.

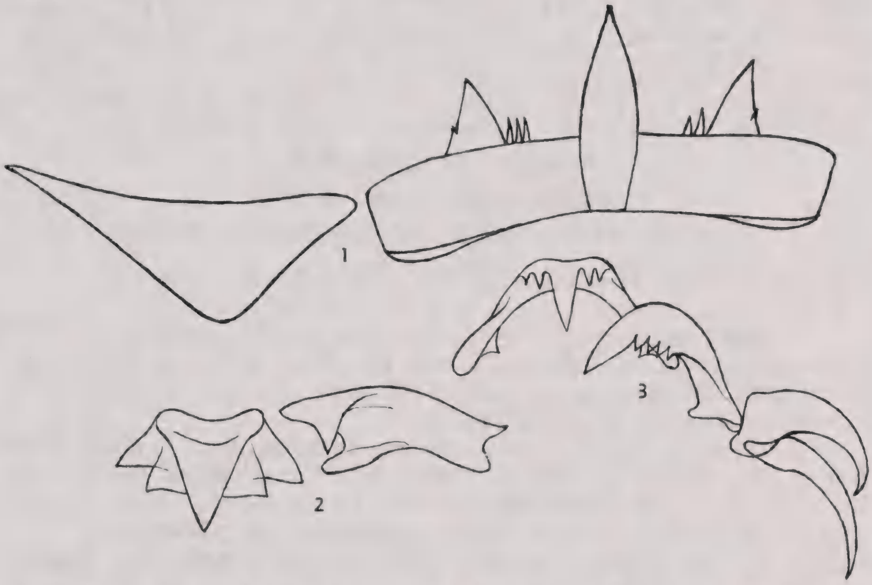
1965—*Polinices tawhitirahia* Powell, Rec. Auck. Inst. Mus., Vol. 6, No. 2, p. 163.

Rec. Auck. Inst. Mus. Vol. 6, No. 3, pp. 185-196, 14th August, 1967.

Type locality—Off the northern tip of Tawhiti Rahi, Poor Knights Islands, at about 120 feet in sand and rubble (empty shells only).

Since this species was described, Mr W. Palmer of Whangarei has taken several living specimens at the type locality. The operculum is horny, dark, almost black, and the radula (text fig. 2) differs from that of most naticoids in having the central tooth with a single massive broadly triangulate cusp, without denticles, not tricuspid, the usual form of the naticoid central tooth; the laterals also are simple, with a large triangulate central, but no subsidiary cusps or denticles; the paired marginals, however, are long and slender as in other naticoids.

The radula of *Tanea zelandica* (Q. & G.) is somewhat similar in having a unicuspid central but the cusp is much more slender and has a deep saddle above. However, *Tanea* belongs to the typical shelly operculate group of naticoids.



RADULAE: Fig. 1 *Morula* (*Oppomorus*) *palmeri* n. sp. Fig. 2 *Polinices tawhitirahia* Powell, 1965. Fig. 3 *Annaperenna verrucosa* (Sowerby, 1825). All Poor Knights Islands.

Family CASSIDIDAE

Genus CASMARIA H. & A. Adams, 1853.

Type: (s.d., Harris, 1897) *Buccinum vibex* Linnaeus, 1758.

Casmaria perryi (Iredale, 1912). Plate 36, Figs. 9, 10.

1910—*Cassidea cernica* (Sowerby), Iredale, Proc. Malac. Soc., 9, p. 71 (non Sowerby, 1888).
1912—*Cassidea perryi* Iredale, Proc. Malac. Soc., 10, p. 227, Pl. 9, fig. 17.
1915—*Cassidea perryi* Iredale, Oliver, Trans. N.Z. Inst., 47, p. 529.
1962—*Casmaria perryi* Iredale, Iredale & McMichael, Austr. Mus. Handb. Mem. no. 11, p. 56.

Type localities—The type locality of *perryi* is Sunday Island (Raoul Island), Kermadec Islands, and that of *cernica* is Mauritius.

Iredale (1910) first recorded the Kermadec shells as *cernica*, then later (1912) described these shells as a new species, *perryi*, stating that they showed "a deceptive resemblance to *cernica* Sowerby, but that species is a smooth relation of *C. vibex*, to which this form is not closely allied."

The species *perryi* is fawn to pale orange-brown, with five spiral bands of maculations on the body-whorl, four of which terminate as darker labial patches; the fifth band consists of more distant subsutural rectangular patches. In the smooth form of *vibex* the labial maculations range between 7 and 9, and the ground colour is ivory to greyish-white.

I now record *perryi* from New Zealand on the basis of one fresh adult specimen and a juvenile taken from rocks just below low water at Oruawharu, south east coast of the Great Barrier Island, by Mrs G. Mitchener, who has the material in her collection at the Great Barrier Island. Another interesting record for the species is Tuncurry, New South Wales (Iredale & McMichael, 1962, l.c.).

Height	width	
43.00 mm.;	24.00 mm.	Kermadec Islands (Holotype of *perryi*)
37.00 mm.;	21.50 mm.	Kermadec Islands.
35.00 mm.;	20.75 mm.	Kermadec Islands.
30.75 mm.;	17.00 mm.	New Zealand, Gt. Barrier Id.
29.00 mm.;	16.00 mm.	Kermadec Islands.

Genus **XENOPHALIUM** Iredale, 1927.

Type: (o.d.) *Xenophalium hedleyi* Iredale, 1927.

Xenophalium royanum (Iredale, 1914)

1914 *Cassidea royana* Iredale, Proc. Malac. Soc. 11, 3, p. 180, text fig.
1927 *Xenophalium royanum* (Iredale), Iredale, Rec. Austr. Mus. 15, 5, p. 333.
1928 *Xenophalium royanum* (Iredale), Powell, Trans. N.Z. Inst. 59, p. 641, pl. 74, figs. 11, 12.

This species is based upon a large weathered specimen cast ashore on the north coast of Raoul Island, Kermadec Islands. Another specimen from the same locality and in a similar condition was collected by Mr T. F. Cheeseman in 1887, and is in the Auckland Museum.

In 1928 I recorded (l.c.) the species from New Zealand with a series of specimens in a good state of preservation, not actually live taken, but inhabited by hermit crabs, from crayfish-pots, in about 20 fathoms off Cavalli Islands and near Stephenson Island off Whangaroa.

Since then several large dead but fresh specimens have been taken at the Poor Knights Islands by the Whangarei group of skin divers, and recently a large living example was obtained at 150 feet on a ledge of bryozoan sand off the N.W. end of Tawhiti Rahi, Poor Knights Islands.

Height	width	
151.0 mm.;	84.5 mm.	Poor Knights Islands (living).
135.0+ mm.	95.0 mm.	holotype.
135.0 mm;	82.0 mm.	off Cavalli Islands.
126.0 mm.;	78 mm.	Stephenson Island, 17 fathoms.

Family CYMATIIDAE

Genus **Charonia** Gistel and Bromme, 1847.

Type: (monotypy) *Murex tritonis* Linnaeus, 1758.

Charonia tritonis (Linnaeus, 1758)

1758 *Murex tritonis* Linnaeus, Syst. Nat. ed. 10, p. 754.
1913 *Septa tritonis* (Linnaeus), Suter, Manual N.Z. Mollusca, p. 304.
1964 *Charonia tritonis* (Linnaeus), Powell, Rec. Auck. Inst. Mus. 6, 1, p. 14.

At the above reference (1964) I recorded this large well known tropical Pacific shell from Wainui Bay, Bay of Islands County, Northland, on the basis of a near adult specimen, in a fairly fresh condition.

I can now record the finding of a fully adult example, also in fairly fresh condition, found washed up among rocks at an isolated spot near Rosalie Bay at the southern end of Great Barrier Island, by Mr K. B. Speer. However it is still inconclusive whether the species actually lives in New Zealand waters since the latter locality is adjacent to an overseas shipping lane.

Genus **PROXICHARONIA** Powell, 1938.

Type: (o.d.) *Charonia (Charoniella) arthritica* Powell & Bartrum, 1929.

This is still another example of an otherwise New Zealand Miocene genus that has survived to Recent times in northern New Zealand waters. Its Miocene relatives are *arthritica* (Powell & Bartrum, 1929) (Otaian), *clifdenensis* (Finlay, 1924) (Altonian) and *neozelanica* (Marshall & Murdoch, 1923) (Awamoan).

From these Tertiary species the Recent one, described below, differs in the form of the peripheral nodules, which are less prominent, more rounded, and more numerous between varices. Another genus closely resembling *Proxicharonia* is the Tasmanian *Negyrina* but it has more rounded whorls and a more capacious body-whorl and aperture.

Owing to a shell injury and its natural repair, forward of the second to last varix, the outline of the holotype of the New Zealand species is narrower and less humped than is shown in a normal but badly damaged and eroded paratype.

Mr Alan Beu, who is writing a revision of the New Zealand and Australian Tertiary Cymatiidae confirms the above generic placing of the New Zealand Recent shell.

Proxicharonia palmeri n. sp. Plate 36, Figs. 11, 12.

Shell of moderate size, 40-43 mm., solid, biconically narrowly ovate, with a slight asymmetrical distortion of the body-whorl, being humped on the left of the body-whorl closely following the second to last labial varix. Varices prominent, broadly rounded, at about two-thirds of a whorl spacing. Spire and aperture plus short recurved, broadly notched anterior canal, about equal in height. Protoconch eroded away. Post-nuclear whorls, besides the varices, sculptured with a low-set peripheral row of moderately large bluntly rounded nodes, 5-6 between varices. Surface sculpture of numerous closely spaced spiral cords, all weakly nodulose, but several on the shoulder slope bearing wider spaced and slightly stronger nodes. Subsuturally the nodes coalesce vertically to form a puckered margining of about one third the shoulder slope area in depth. In addition the entire surface is densely and finely lirate. Aperture narrowly ovate, rather heavily variced, its outer edge thin, but thickened and dentate within. Inner lip a broad clearly defined callus, bearing a strong entering parietal fold, and about 17 rather weak plicae over the rest of the callus, those toward the anterior canal somewhat stronger. Colour golden brown, aperture and inner-lip callus white; the whole surface normally covered by a yellowish-brown periostracum, which reproduces and emphasises the surface sculpture.

The holotype was inhabited by a hermit crab and this has caused surface wear to the ventral surface making the peripheral nodes appear larger, blunt and smooth.

Locality—One mile off the northern end of the Poor Knights Islands (Northern Reef) at a depth of 140 feet (Mr W. Palmer).
Height 43+ mm.; width 20.0 mm. holotype.
Height 39+ mm.; width 19.5 mm. paratype.
Holotype—Presented to the Auckland Museum by the finder Mr W. Palmer of Whangarei. Paratype in Mr Palmer's collection.

Family BURSIDAE

Genus **Tutufa** Jousseaume, 1881.

Type: (o.d.) *Murex lampas* Linnaeus, 1758.

Tutufa bufo (Röding, 1798). Plate 36, Fig. 8.

1798 *Tritonium bufo* Röding, Mus. Bolt. 2, p. 128 (based upon Martini, 1780, Conch. Cab. 4, pl. 129, fig. 1238.
1842 *Triton lampas* Lamarck (non Linnaeus, 1758), Kiener, Coq. Viv. Triton, p. 38, pl. 5, fig. 1.
1906 *Tutufa (Crossata) californica* (Hinds); Suter, Trans. N.Z. Inst. 38, p. 328 (non Hinds, 1844).
1914 *Bursa (Tutufa) rubeta lissostoma* Smith, Journ. of Conch. 24, p. 230, pl. 4, fig. 3.
1915 *Bursa siphonata* (Reeve); Oliver, Trans. N.Z. Inst. 47, p. 528 (non Reeve, 1845).
1931 *Tutufa lissostoma* (Smith, 1914), Iredale, Rec. Austr. Mus. 18 (4), p. 214, pl. 23, fig. 5.
1960 *Bursa (Tutufa) bufo* (Röding); Kira, Col. Illustra. Shells Japan, pl. 21, fig. 20 (flared red-lipped form).
1962 *Tutufa bufo* (Roding); Iredale & McMichael, Mem. 11, Austr. Mus., Sydney, p. 55.
1963 *Tutufa bufo* (Röding), Oyama & Takemura, The Moll. Shells, 6, Tutufa, pl. 2, figs. 2-4.

Locality—Poor Knights Islands, off the north-west end of Tawhiti Rahi Island at about 150 feet. One living female specimen and another (not seen) obtained by the Whangarei group of skin divers.

The identity of this exotic species is very involved from a nomenclaturial standpoint, but basically it is dependant upon the interpretation of Chemnitz's figure in Martini (Conch. Cab. 4, pl. 129, fig. 1238). Chemnitz's figure could almost equally well apply to a young example of *lampas* (Linnaeus, 1758).

The shell I now record for New Zealand is the Indo-Pacific red-mouthed *Tutufa* with the considerably expanded outer lip, especially basally, and with only a weak development of labial tubercles .

I have red-mouthed, splayed lip shells identical with the New Zealand shell from the following localities — Raoul Island, Kermadec Islands, 75-85 metres (Galathea Exped. 3-3-1952); Denham Bay, Raoul Island (coll. T. F. Cheeseman, 1887; the specimen identified as *californica* by Suter, 1906, and *siphonata* by Oliver, 1915); Bougainville, Solomon Islands (AM18221). These are identical with the Japanese shells figured by Kira (l.c.) and Oyama & Takemura (l.c.) as *bufo,* and the Indian Ocean shell described and figured by Smith as *rubeta lissostoma* (l.c.). Iredale (1931, Rec. Austr. Mus. 18, p. 214, pl. 23, fig. 5) accepted *lissostoma* as the valid name for the red-mouthed *Tutufa* from Sydney Harbour, but later (Iredale & McMichael, 1962, l.c.) relegated Smith's name to the synonymy of *bufo.*

Since the majority view seems to be in favour of *bufo* as the correct name for the red-mouthed *Tutufa,* there the matter rests for the present, but if it should be proved that *bufo* (Röding, 1798) is the same as *lampas* (Linnaeus, 1758) then Smith's *lissostoma* will be the name to be used for the red-mouthed shells.

Height 170.0 mm.; width 111.0 mm. Bougainville.
Height 140.5 mm.; width 87.0 mm. N.Z., Poor Knights Is.
Height 108.0 mm.; width 78.0 mm. Kermadecs, Denham Bay.
Height 103.0 mm.; width 65.0 mm. Kermadecs, 75-85 metres.

Genus **Annaperenna** Iredale, 1936.

Type: (o.d.) *Ranella verrucosa* Sowerby, 1825 = *Murex papilla* Wood, 1828.

Annaperenna verrucosa (Sowerby, 1825).

1825 *Ranella verrucosa* Sowerby, Cat. Coll. Tankerville, Append. p. 18.
1965 *Annaperenna verrucosa* (Sowerby), Powell, Rec. Auck. Inst. Mus. 6, 2, p. 162, pl. 22, figs. 5, 6.

Type locality—Probably Norfolk Island (Iredale, 1936, Rec. Austr. Mus. 19, p. 310). Also known from Lord Howe Island, Kermadec Islands, Sydney Harbour (dredge spoil) and Poor Knights Islands, northern New Zealand at 50 and 150 feet.

Mr Byron Anderson, one of the Whangarei group of skin divers responsible for the above Poor Knights Islands records, has extended the range of the species to the eastern Bay of Plenty by the finding of a giant sized example, 57 mm. x 33 mm., taken at 150 feet off Club Rocks, S.W. of White Island (April, 1966).

The operculum is irregularly ovate with a subterminal nucleus. The radula (text fig. 3) is very like that of *Bursa crumena* (Lamarck) as figured by Thiele (1929, Handb. Syst. Weicht. 1, p. 284, fig. 304). It consists of a saddle-shaped central with a long central cusp and a pair of smaller cusps on each side; lateral massive, strongly arched, bearing four cusps about midway along its outer edge; and a pair of sickle-shaped marginals, the inner one massive, the outer one slender.

Family TONNIDAE

Genus **TONNA** Brunnich, 1772.

Type: (monotypy) *Buccinum galea* Linnaeus, 1758.

Tonna melanostoma (Jay, 1839). Plate 36, Figs. 6, 7.

1839—*Dolium melanostoma* Jay, Catal. of Shells, 3rd. Edit., p. 125, Pl. 8, 9.
1848—*Dolium melanostoma* Jay, Reeve, Conch. Iconica, 5, Pl. 2, fig. 2.
1885—*Dolium melanostoma* Jay, Tryon, Man. of Conch., 7, p. 261, Pl. 1, fig. 4.
1943—*Tonna melanostoma* (Jay), Osima, Conch. Asiatica, 1, p. 118, Pl. 2, fig. 2.
1961—*Tonna melanostoma* (Jay), Habe, Col. Illust. Shells of Japan, 2, Pl. 24, fig. 8.
1964—*Tonna melanostoma* (Jay), Habe, Shells of the Western Pacific, in colour, 2, p. 77, Pl. 24, fig. 8.

Type locality—"Friendly Islands" = Tonga. Widely distributed in the tropical Pacific, and occasionally taken at the Ryukyu Islands on fine sandy bottom in from 5 to 20 metres (Habe, 1964).

This species can now be added to the New Zealand fauna on the basis of one live taken specimen, from off the Cavalli Islands, in the possession of Mr Bruce Sanderson of Whangaroa, another trawled off Doubtless Bay, in the collection of Mrs J. Atkinson of Mangonui, and a third record, a beach shell found at Spirits Bay, in the collection of Mrs M. J. Hancock of Whangarei.

This shell is easily recognised by its rich dark-brown spreading parietal callus, and deeply incised twin grooves in each of the spiral interspaces. The interior of the aperture is golden-brown with the inner edge of the outer lip tinged with dark-brown. The exterior of the shell is fawn, the spaces between the broad spiral ridges are picked out in brown, and there are distant obscure spiral bands as well.

The Cavalli Island shell is a small one — height 86.0 mm., width 68.0 mm.; Reeve's figure (l.c.), presumably natural size, shows a shell with a height of 190 mm. (= 7½ inches), and Tryon (l.c.) gives the adult height as 9 inches.

Tonna olearium (Linnaeus, 1758).

1758 *Buccinum olearium* Linnaeus, Syst. Nat. ed. 10, p. 734.
1927 *Tonna tetracotula* (not of Hedley, 1919), Powell, Trans. N.Z., Inst., Vol. 57, p. 559, Pl. 32.
1956 *Baccinum olearium* Linnaeus, Dodge, A Hist. Rev. Moll. Linn., Pt. 4, Bull. Amer. Mus. Nat. Hist., Vol. 3 (4), pp. 160-164.
1956 *Tonna olearium* (Linnaeus), Kaicher, Indo-Pac. Sea Shells, Tonnacea, Pl. 5, fig. 7.
1962 *Tonna olearium* (Linnaeus), Kira, Coloured Illust. Shells of Japan, Pl. 22, fig. 10.

It is now revealed that there are two species of large *Tonna* occurring in northern New Zealand waters that exhibit intercostal subsidiary spiral threads.

In the past both of these species have been assigned to the S.E. Australian *tetracotula* Hedley, 1919. However a series of six specimens in the collection of Mrs J. Atkinson of Mangonui, trawled in Doubtless Bay, are thin shelled, without a thickened internal ridge to the outer lip, and of simple coloration, uniform chestnut-brown but fading to white in a broad subsutural band.

In true *tetracotula* the outer lip has an internal ridge and the coloration is pale buff with two or three broad spiral bands of reddish-brown.

When I first recorded *"tetracotula"* from New Zealand (Powell, 1927, l.c.) the specimen cited and figured proves to be the uniformly coloured, thin-lipped *Tonna,* which seems to be the Linnaean *olearium,* a species that has been the subject of considerable controversy. On the other hand many New Zealand examples of the true *tetracotula* have since been obtained from trawlers operating in Northland east coast waters and in the Bay of Plenty.

Regarding the true identity of Linnaeus' *olearium* the name has long been misapplied to another Indo-Pacific species that does not have intercostal spirals, i.e., the *olearium* of Bruguière, 1789 (Ency. Meth., p. 243). Dodge (1956, l.c.) points out that Linnaeus' brief original description of *olearium,* "B. testa subrotunda cincta sulcis obtusis: lineola elevata interstinctis, apertura edentula" definitely applies to a species with intercostal spirals, which precludes the interpretations of Bruguière and those of many other authors, i.e., Reeve, 1849, and Tryon, 1885.

After a lengthy and informative discussion Dodge (1956, l.c., p.p. 160-165) gave a convincing case for the identity of the true *olearium,* as here interpreted, and at the same place provided a new name, *planicostata,* for the shell of Bruguière and others.

The type locality for *olearium* is "O. Indico", it is recorded from Japan in 20 fathoms by Kira (1962, l.c.), and the New Zealand records are:

trawled near the entrance to the Hauraki Gulf or western Bay of Plenty (Powell, 1927, l.c.) and trawled, Doubtless Bay (Mrs J. Atkinson).
Height 200 mm.; diameter 157 mm.; weight 5 ounces (shell) (Powell, 1927). The Mangonui specimens are all smaller than the above.

The species of *Tonna* known to occur in New Zealand waters are now as follows:— *cerevisina haurakiensis* Hedley, 1919; *maculata* (Lamarck, 1822) (= *dolium* of Powell 1952; non Linnaeus, 1758); *maoria* Powell, 1938; *melanostoma* (Jay, 1839); *olearium* (Linnaeus, 1758) and *tetracotula* Hedley, 1919.

An additional record for New Zealand occurrences of *maculata* is three live taken or fresh specimens in the collection of Mrs J. Atkinson of Mangonui, which were trawled off Doubtless Bay.

Family MURICIDAE

Genus **Pteropurpura** Jousseaume, 1880.

Type: (monotypy) *Murex macropterus* Deshayes, 1839.

(See Emerson, 1964, Veliger, 6, 3, p. 151, pl. 19, fig. 2)

Pteropurpura cf. plorator (Adams & Reeve, 1850).

Plate 37, Figs. 1-4.

1850 *Murex plorator* Adams & Reeve, Zool., Voy. H.M.S. Samarang, p. 38, pl. 8, fig. 3a, b.

A young specimen attributed to this three-winged species, the type of which came from Korea, was trawled in Northland, New Zealand, probably in the North Cape-Three Kings area.

The Korean type is dark chestnut with a narrow supra-peripheral pale band, but in other material (off Tosa, Japan) the coloration is more or less uniformly pale yellowish brown with three indistinct narrow bands of slightly darker dashes. The most characteristic feature of the species is a single peripheral blunt rounded boss between each pair of winged varices.

The New Zealand shell is immature, which makes exact comparison uncertain, but this specimen does have the single boss between varices and similar coloration to that of Japanese shells; the anterior canal is open for its entire length, not partially closed as in adult Japanese shells, but this is to be expected in a juvenile.

Height 48.0 mm.; width 22.5 mm. type of *plorator*.
Height 32.0 mm.; width 19.0 mm. type of *modesta*.
Height 21.5 mm.; width 13.0 mm. (distances between varices, 13 mm, 12 mm. and 14.5 mm.), New Zealand immature shell.

The Japanese *Ocinebra* (*Ocinebrellus*) *modesta* Fulton, 1936 (Proc. Malac. Soc. 22, p. 10, pl. 2, fig. 3) appears to have several small nodes between the varices, but is otherwise very similar to *plorator*. The genus *Ocinebrellus* Jousseaume, 1880, type (o.d.) *Murex eurypteron* Reeve, 1845 (Japan) is a larger and heavier shell, with more numerous varices that do not line up from whorl to whorl.

The New Zealand shell is in the collection of Mrs N. Gardner, Auckland.

This record not only adds a genus to the New Zealand fauna but also considerably extends its range, which previously, was Korea and Japan to California.

Family THAISIDAE

Genus **Morula** Schumacher, 1817.

Subgenus **Oppomorus** Iredale, 1937.

Type: (o.d.) *Purpura noduliferus* Menke, 1829 (= *Purpura chaidea* Duclos, 1832).

Morula (Oppomorus) palmeri n. sp. Plate 37, Figs. 10-13.

Shell ovate-cylindrical, solid, dull white externally, porcellanous-white within the aperture and over the spreading inner lip. Spire less than height of aperture, which is narrowly rectangular, with a thin-edged outer lip, unarmed except for weak internal lirations. Protoconch rather broadly conical of 4 to 4½ whorls, apparently smooth, except for a suprasutural weakly beaded thread, and ending abruptly with a thin reflected vertical rim-like axial. Adult sculpture of numerous strong rounded axial folds crossed by spiral cords which develop strong laterally elongated nodes on the axial folds but are obsolete over the intercostal spaces. The number and relative strengths of the spiral cords is subject to considerable variation. The basic arrangement for the early spire whorls is a broad subsutural fold, followed by a sulcus, then two closely spaced cords over the lower half of the whorls; and these increase to 3 or 4 by the end of the penultimate; the cords on the body-whorl are usually 9, sometimes 10, and occasionally only 6 or 7. A weak thread is sometimes present in the shoulder sulcus.

Height 20.75 mm.; width 11.0 mm. holotype.
Height 21.5 mm.; width 11.0 mm. paratype.

Localities—Poor Knights Islands, north-west end of Tawhiti Rahi Island, on boulders in floor of large cave at 60-80 feet depth (holotype) (W. Palmer); Werahi, near Cape Maria van Diemen (1 dead shell) (N. Gardner, 1965). The cave at Piercy Island, Cape Brett at 45 feet (W. Palmer).

The species resembles *nodulifera* (Menke, 1829) (= *chaidea* Duclos, 1832) but lacks the two weak denticles at the base of the pillar. Also in *nodulifera* the spiral cords are continuously undulated over axials and interspaces alike, the spiral interspaces are linear, bridged by dense lamellate axial threads, and the aperture is proportionately smaller.

The radula in *palmeri* consists of a wide but shallow-based tricuspid central tooth, the central cusp being much the strngest; at the base of the side cusps there are 2 or 3 denticles on the inner face and 1 on the outer face; and the lateral is shaped somewhat like an isosceles triangle.

The radula (text fig. 1) most closely resembling that of the New Zealand species is that of the Indo-Pacific *Morula cavernosa* (Reeve, 1846), as figured by Arakawa (1965, Venus, 24, 2, pl. 14, figs. 13, 14). The main difference is in the lateral which is more L-shaped in *cavernosa*. Arakawa used *Morulina* Dall, 1923 for this species, but its type species, *mutica* (Lamarck), is very solid, of squat ovate shape, is prominently dentate within the outer lip, and has a well developed parietal callus pad.

Holotype and paratypes presented to the Auckland Museum by Mr W. Palmer of Whangarei.

Family MAGILIDAE

Genus **Liniaxis** Laseron, 1955.

Type: (o.d.) *L. elongata* Laseron, 1955.

Liniaxis sertata (Hedley, 1903). Plate 37, Figs. 5, 6.

1903 *Purpura sertata* Hedley, Mem. Aust. Mus. 4 (6), p. 382, t. figs. 95, 96.

1955 *Liniaxis sertata* (Hedley). Laseron, The Mar. Zool., Sydney 1 (3), p. 73, pl. 1, figs. 7, 8.

Type locality—New South Wales, off Port Kembla, 63-75 fathoms.

This species can now be added to the New Zealand fauna on the basis of the following records:-

North West Reef, between Little Barrier Island and Taranga (Hen Island), 30 fathoms, 3 living specimens on an antipatharian coral (sea-tree), Mr C. Wormald: Kopu Wairoa, Spirits Bay, in shell-grit on island, Mr M. Douglas, May, 1966 (1 worn shell).

The correct name for this new addition is fixed tentatively as *sertata* (Hedley, 1903), for according to Laseron (1955, l.c. p. 70), confusion resulted from the fact that the assumed adult of Hedley's species, the "*sertata*" of Iredale, 1929 (Rec. Aust. Mus. 17,4, pl. 41, figs. 3,8), there cited as type of a new genus, *Tolema,* was an undescribed species, for which Laseron provided the new name *australis.*

The true adult of Hedley's species, according to Laseron, is another genus, close to *Coralliophila,* and which he named *Liniaxis,* with a new species, *elongata* as type. Since Iredale figured his own interpretation of Hedley's *sertata* in citing the type species for *Tolema* it is reasonable to accept Laseron's contention that the type should be interpreted upon the basis of Iredale's figure rather than upon Hedley's name.

Laseron (1955, l.c. pp. 72-74) listed three species under his *Liniaxis*:- *elongata* n.sp. (type), *sertata* (Hedley, 1903) and *nodosa* (Adams, 1853). Upon the basis of photographs submitted, Dr. D. F. McMichael of the Australian Museum, Sydney, considered that the New Zealand shells were identical with the true *sertata* of Hedley.

Another point was raised by Mr W. F. Ponder of the Dominion Museum, Wellington, who noted the similarity to *Liniaxis* of *Murexsul tepikiensis* Powell, 1934 (Rec. Auck. Inst. Mus. 1, 5, p. 272) from Cape Runaway (Castlecliffian; upper Pleistocene). Undoubtedly *tepikiensis* must be transferred to *Liniaxis,* but specifically, the Cape Runaway fossils are distinguishable from *sertata* by the more rounded non-carinated whorls.

The New Zealand shells are pinkish-white, sculptured with numerous linear-spaced keels that bear closely packed imbricated scales in a cone-in-cone manner. This sculpture overrides rather distant weak to moderately strong axials, strongest at a peripheral subangle. A feature of the shell is the strongly imbricated anterior fasciole. Interior of the aperture rose-pink.

Height 22.0 mm.; width 12.5 mm. New Zealand, N.W. Reef.
Height 19.0 mm.; width 10.5 mm. New Zealand, N.W. Reef.
Height 18.0 mm.; width 10.0 mm. New Zealand, N.W. Reef.

Family FASCIOLARIIDAE

Subfamily FUSININAE

Genus FUSINUS Rafinesque, 1815.

Type: (monotypy) *Murex colus* Linnaeus, 1758.

Fusinus genticus (Iredale, 1936). Plate 36, Figs. 4, 5.

1936 *Colus genticus* Iredale, Rec. Austr. Mus., 19, p. 316, Pl. 23, fig. 5.

1962 *Fusinus genticus* (Iredale), Iredale & McMichael, Mem. 11, Austr. Mus., Sydney, p. 69.

This species, and with it a genus, can now be added to the New Zealand Recent fauna on the basis of several specimens, in a fresh state, inhabited by hermit crabs, taken in crayfish-pots, in the vicinity of Doubtless

Bay, the Cavalli Islands and the Great Barrier Island. One of these specimens, that figured, is from the Cavalli Islands, and was presented to the Auckland Museum by Mr S. E. Turner. The Great Barrier Island example, referred to below, is in the collection of Mr Turner.

Shell large, 110-150 mm., of rather light build, rather broadly fusiform for the genus, with a tall spire and a long straight anterior canal. Protoconch missing; adult whorls sharply carinated below middle whorl height, the carina bearing sharply pointed nodes, 14 on the last whorl, and the whole surface crossed by closely spaced spirals of uneven development. On the spire-whorls, from the peripheral carina to the lower suture, 3-4 of the spirals assume primary strength and there is a fairly regular development of primaries over the rest of the shell. Aperture ovate, quickly contracted to a long straight and narrow anterior canal. Inner lip a smooth light callus with a slightly raised free edge; no parietal processes and only an obscure slightly thickened columellar ridge at the base of the aperture proper. Outer lip thin and slightly dilated; weakly spirally lirate within. Colour dull white; but in the Great Barrier Island specimen there is a faint colour pattern also in the form of pale yellowish-brown zones, one occupying the whole of the shoulder slope and another partly emergent at the lower suture. Slightly darker yellowish-brown maculations alternate with the peripheral nodes. Also there are traces of a thick brownish-olive pile-like periostracum.

Height, 111.0 mm.; width 39.0 mm. Holotype; Sydney Harbour dredgings.
Height, 148.5 mm.; width 56.0 mm. Off Cavalli Islands, in crayfish-pots.
Height, 160.0 mm.; width 59.0 mm. N.E. of Great Barrier Island, 30 fathoms.

This shell is deceptively like a *Penion* but can at once be distinguished by its long straight canal.

Type locality—New South Wales, Sydney Harbour dredging dump.

Family APLYSIIDAE

Genus **Dolabrifera** Gray, 1847.

Type: (o.d.) *Dolabella dolabrifera* Cuvier, 1817.

Dolabrifera brazieri (Sowerby, 1870).

1870 *Dolabrifera brazieri* Sowerby, Proc. Zool. Soc., p. 250.
1896 *Dolabrifera jacksoniensis* Pilsbry, Man. Conch., 16, p. 120, Pl. 44, figs. 38-41.
1917 *Dolabrifera brazieri;* Hedley, Proc. Linn. Soc. N.S.W., 41 (4), p. 717, Pl. 49, fig. 25.
1950 *Dolabrifera brazieri;* Allan, Aust. Shells. p. 216, figs. 2, 5.
1962 *Dolabrifera brazieri;* Iredale & McMichael, Ref. List. Mar. Moll. N.S.W., Aust. Mus. Mem., 11, p. 91.

The finding of three living specimens of this species at Taiharuru, near Pataua, Whangarei Heads, adds a genus and species to the New Zealand fauna. The finder, Mrs Ida Worthy of Whangarei, states that these molluscs were crawling upon silty gravel bottom at low tide in gutters amongst the rocks at the mouth of a tidal stream.

The animal is between 3 and 4 inches in length and 1½ to 2 inches in breadth; gradually tapered toward the anterior end. According to Hedley (1917, l.c.) "the colour is olive-brown ,variegated with buff, and tinged at the margin and on the tentacles and rhinophores, with green. Upon the back are about a score of warty protruberences, which rise or subside at the will of the animal, and from the summit of which a white filament may project for two or three millimetres, or be withdrawn.

"The tentacles are comparatively short and broad, bell-shaped, split nearly to the base, with ragged margin. The rhinophores are narrow, more cylindrical, less deeply notched ,set farther back on the neck. Just in front of these are the sessile, inconspicuous black eyes.

"The posterior orifice is set far back, is ovate, about 6 mm. long, with erect margins and an inner lobe rising at the anterior end. In front of this, the right side of the mantle overlaps the left. The gill is never exserted."

The type locality of the species is Botany Bay, New South Wales.

One of the Pataua specimens measures (in a spirit contacted condition) 68 mm. in length, 42 mm. in greatest breadth and about 18 mm. in thickness. The characteristic hatchet-shaped internal shell is 16.5 mm. in height and 7 mm. in maximum breadth.

Family SEMELIDAE

Genus SEMELE Schumacher, 1817.

Type: (monotypy) *Tellina reticulata* "Spengler" Schumacher, 1817

= *Tellina proficua* Pulteney, 1799.

This genus is now added to the New Zealand fauna on the basis of a species assumed to be new, represented at present by but a single specimen, but it is anticipated that others will be found, since it has probably been overlooked owing to its strong superficial resemblance to the tellinid *Zearcopagia disculus* (Deshayes, 1855).

The New Zealand species seems to be nearest allied to the Indian Ocean *Amphidesma crenulatum* G. B. Sowerby, 1841 (Conch. Illustr. Catal., p. 8), a shell I have not seen, but from illustrations, including that of Reeve, 1853 (Conch. Iconica 8, pl. 2, fig. 8), the New Zealand shell appears to be much finer sculptured.

Semele brambleyae n. sp. Plate 37, Figs. 7-9.

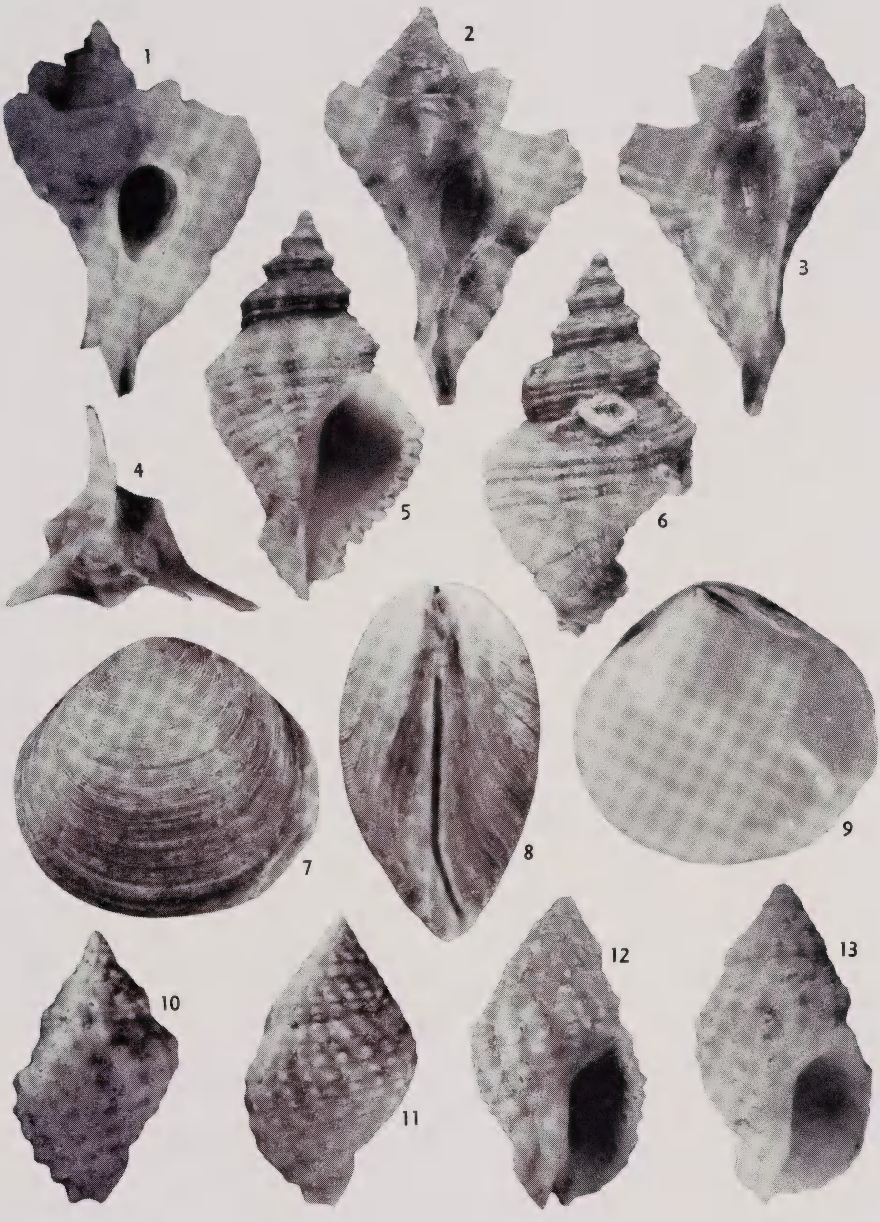
Shell orbicular, equilateral, of moderate inflatin, solid, with a distinct posterior fixture, and a large elongated resilifer and pit, lying obliquely in the middle of the hinge plate. Sculpture dense and elaborate, consisting for the most part of very closely spaced, distinctly crenulated, lamallate, concentric lamellae, with dense connecting radial threads, enclosing vertical narrowly ovate pits. The prodissoconch is very small, smooth, and sharply pointed, but between it and the commencement of the adult sculpture there is a phase, occupying 4 mm., of much wider-spaced and smooth lamellae, with finely radially lirate interspaces but no pits. The concentric lamellae number about 25 per centimeter over the middle area of the shell. Hinge normal for the genus; cardinals narrow and weak, laterals strong. Valve margins smooth to microscopically densely crenulated. Pallial sinus large and deep, with a broadly rounded apex, and ascending to the middle of the shell. Colour yellowish-buff, without markings, and with a thin light brownish periostracum. Interior of valves shining, ivory, tinged with chrome.

Length 32.5 mm.; height 31.0 mm.; inflation (both valves) 18.0 mm.

Locality—East end of Orua Bay, Manukau Harbour (on mud flat, one empty shell, in a fresh state, with joined valves).

Holotype—Presented to the Auckland Museum by the finder, Miss Dianne Brambley of Wattle Bay, Manukau Heads.

Figs. 1-3 *Lyncina vitellus* (Linnaeus, 1758) Poor Knights Islands. Figs. 4, 5 *Fusinus genticus* (Iredale, 1936) Doubtless Bay. Figs. 6, 7 *Tonna melanostoma* (Jay, 1839) Cavalli Islands. Fig. 8 *Tutufa bufo* (Roding, 1798) Poor Knights Islands. Figs. 9, 10 *Casmaria perryi* (Iredale, 1912) Great Barrier Island. Figs. 11, 12 *Proxicharonia palmeri* n. sp. (holotype) Poor Knights Islands.



Figs. 1-4 *Pteropurpura cf. plorata* (Adams & Reeve, 1850) Japan (Fig. 1), North Cape-Three Kings area (Figs. 2-4). Figs. 5, 6 *Liniaxis sertata* (Hedley, 1903) N. W. Reef, nr. Little Barrier Island. Figs. 7-9 *Semele brambleyae* n. sp. (holotype) Orua Bay, Manukau Harbour. Figs. 10-13 *(Oppomorus) palmeri* n. sp. Poor Knights Islands (holotype fig. 12).

MOLLUSCA OF THE KERMADEC ISLANDS PART 2

By A. W. B. POWELL, Auckland Museum.

ABSTRACT

In this part three new species are described of the genera, *Baryspira, Fusinus* and *Lutraria,* respectively. The *Baryspira* is remarkable in that it belongs to the subgenus *Spinaspira,* which previously did not have a Recent representative. The subgenus is known from the lower Miocene to the lower Pliocene of New Zealand and the Miocene of France. The first part of this series appeared in these 'Records' (1958 Vol. 5, Nos. 1 & 2, pp. 65-85). In subsequent parts it is proposed to review the whole of the Kermadec Island molluscan fauna.

Family FASCIOLARIIDAE

Subfamily FUSININAE

Genus **FUSINUS** Rafinesque, 1815.

Type: (monotypy) *Murex colus* Linnaeus, 1758.

Fusinus galatheae n. sp. Plate 38, Fig. 3

Shell rather large, elongate fusiform, combining the characters of *colus* (Linnaeus) with those of *nicobaricus* (Lamarck). It has the sculpture of *colus,* i.e., pointed tubercles, confined to a peripheral carina, relatively weak spiral cords, and the style of aperture of *nicobaricus,* i.e., a broad free thin edged inner lip and a relatively short and stout, double flexed anterior canal. Spire tall, about five sevenths height of aperture plus canal. Protoconch eroded. Post-nuclear whorls angulated at just below middle whorl height; shoulder slope straight, wide and steeply descending. Axial sculpture of weak vertically compressed tubercles confined to the peripheral carina. Spiral sculpture of somewhat irregularly developed cords and threads, 3-5 primary cords from the periphery to the lower suture. On the base the primary cords are more regularly spaced, with 2-3 threads in each interspace. Aperture ovate, relatively large; outer lip delicately crenulated, and lirate within; inner lip very broad and smooth, with a thin free outer edge, raised 5 m.m. out from the columella. Aperture proper and anterior canal of approximately equal height. Anterior canal relatively short, stout and double flexed. Colour dull white without maculations. Operculum leaf-shaped with a terminal nucleus.

Height 96.0 mm.; width 33.0 mm. Holotype.

Localities—Raoul Island, Kermadec Islands; "Galathea" Sta. 674, 29° 15′ S., 177° 57′ W., 75-15 metres, Mar. 3, 1952 (Holotype); "Galathea" Sta. 675, 29° 13.5′ S., 177° 52′ W., 58-60 metres, Mar. 3, 1952.

Holotype—In the University Museum, Copenhagen.

Rec. Auck. Inst. Mus. Vol. 6, No. 3, pp. 197-200, 14th August, 1967.

Family OLIVIDAE

Genus **Baryspira** Fischer, 1883.

Subgenus **Spinaspira** Olson, 1956.

Type: (o.d.) *B.* (*S.*) *stortha* Olson, 1956.

Shells of this subgenus are characterised by a low conic spire, a heavy parietal callus, and a strong callused peripheral spiral keel. Altonian, lower Miocene to Waitotaran, lower Pliocene of New Zealand. There is also a Miocene species, *B. glandiformis* (Lamarck) (Cossmann, Essais Pal. Comp. 3, p. 65, pl. 3, f. 3) from the Burdigalian and Helvetian of France, but the species described below makes the first Recent record for the subgenus.

Baryspira (Spinaspira) raoulensis n. sp. Plate 38, Figs. 4, 5.

Shell large and very solid, subcylindrical, with a short broadly conical spire; apex eroded. Parietal callus strong and wide-spreading, extending above to the shoulder slope of the penultimate whorl, as well as a little distance back from the aperture, on the shoulder slope of the body-whorl. There are two pronounced callus pads, a long one from the parietal wall to the penultimate, and another behind the aperture on the shoulder slope; a long vertical groove separates the two. The peripheral angle of the body-whorl is encircled by a prominent smooth keel-like spiral ridge. The coloration is distinctive; spire down to about one sixth body-whorl height is brownish-orange, then the broad body-whorl median area is almost equally divided by a chocolate upper band and a lower white band. Below this, and immediately above the anterior fasciole there is a narrow band of brownish-orange. The holotype is beach worn and faded so the indication is that a fresh specimen would be much darker, especially the median chocolate band.

Height 56.0 mm.; width 30.0 mm.

Locality—Denham Bay, Raoul Island, Kermadec Islands (T. Iredale, 1908).
Holotype—Australian Museum, Sydney (C. 64838).
Paratype—Dominion Museum, Wellington.

Family MACTRIDAE

Subfamily LUTRARIINAE

Genus LUTRARIA Lamarck, 1799.

Type: (s.d., Gray, 1847) *Mya oblonga* Gmelin, 1790.

Lutraria bruuni n. sp. Plate 38, Figs. 1, 2.

1910—*Lutraria oblonga* (Gmelin), Iredale, Proc. Malac. Soc., 9, p. 72 (non *Mya oblonga* Gmelin, 1790).
1915—*Lutraria magna* (Costa), Oliver, Trans. N.Z. Inst., 47, p. 556 (non *Chama magna* da Costa, 1778, Brit. Conch., p. 230.

I have not seen the shells, "valves dredged near Sunday Island", which both Iredale and Oliver ascribed to English species, but I have a series of valves dredged by the "Galathea" from off Raoul Island (=Sunday Island) in 15-83 metres, which can be considered topotypic of both Iredale's and Oliver's records.

The Kermadec shells are rather similar to the English type species of the genus in that the posterior gape is slight; the posterior slope, however, is long and straight, the ventral margin is more strongly and evenly arcuate,

and the narrowly subangulate points of maximum length of the shell are above middle height. An important difference is in the shape of the resilifer pit, which is obliquely broadly triangular in the English species but inverted comma-shaped in the Kermadec shells. Also there is a weak internal groove running from the resilifer to the ventral margin in the English *lutraria* (Linnaeus, 1767) but this feature is absent from the Kermadec shells.

The Kermadec species is of light build, white, with traces of an olive-brown periostracum and the surface is smooth apart from numerous weak growth lines.

The Kermadec shell is unlike the southern and south-eastern Australian *rhynchaena* Jonas, 1844, in which the posterior dorsal slope is strongly concave. The straight posterior dorsal slope of *bruuni* can be matched in *elongata* Gray, 1837, but that species has the ventral margin long and straight also, not strongly arcuate.

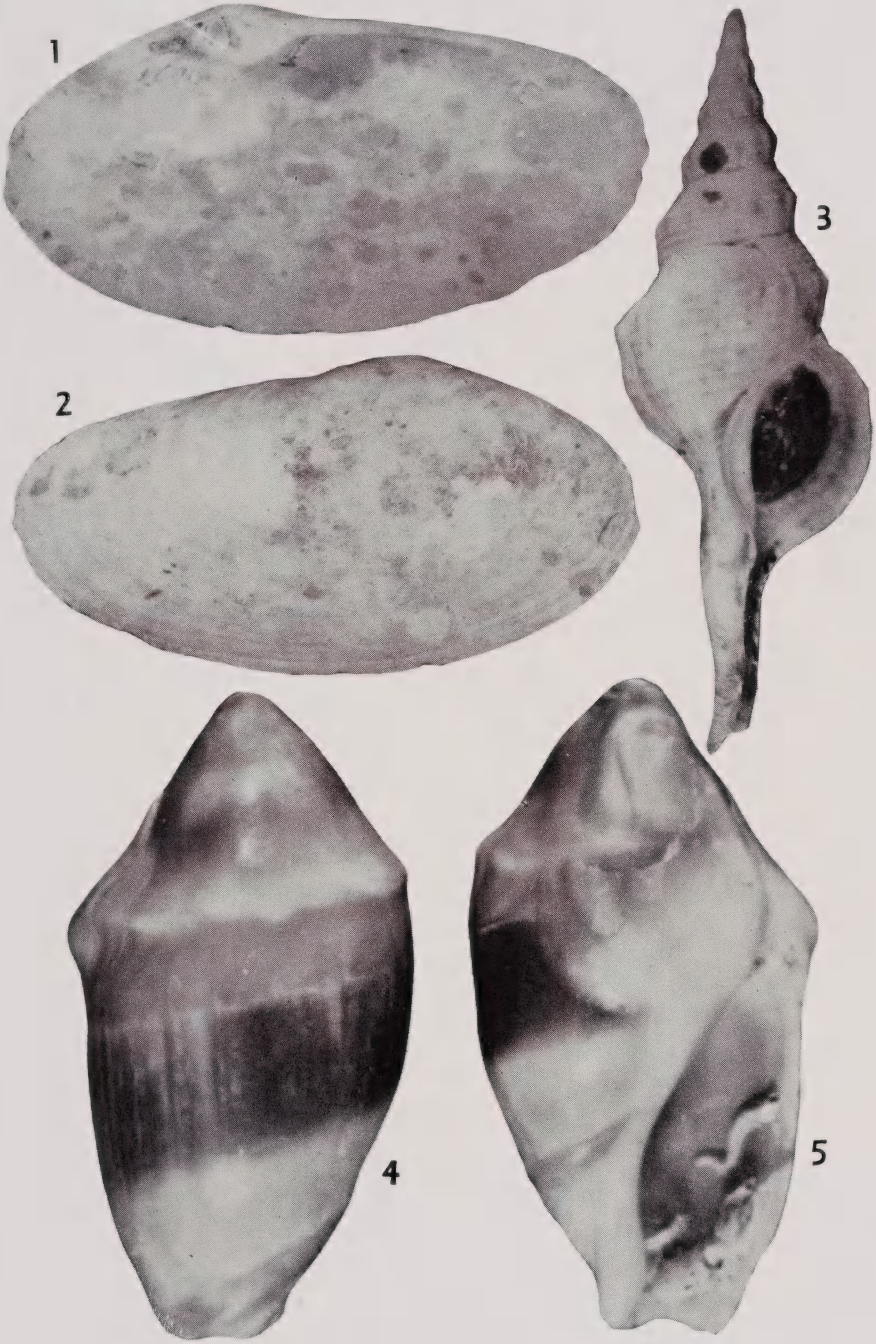
It may be noted that Iredale (1929, Mem. Queensl. Mus., 9, 3, p. 268) renamed this species *Lutraria (Lutromactra) impedita* on account of a prior *L. elongata* of Muenster, 1835, but no reason or diagnosis was given for the proposed new subgenus.

Length 71.0 mm.; height 37.0 mm.; thickness (1 valve) 9.0 mm. Holotype.

Length 57.25 mm.; height 29.0 mm.; thickness (1 valve) 7.0 mm. Paratype.

Localities—Raoul Island, Kermadec Islands; "Galathea" Sta. 676, 29° 13.5′ S., 177° 57′ W., 83 metres, Mar. 3, 1952 (Holotype); "Galathea" Sta. 674, 29° 15′ S., 177° 53′ W., 75-15 metres, Mar. 3, 1952 (Paratype).

Holotype—In the University Museum, Copenhagen.



Figs. 1, 2 *Lutraria bruuni* n.sp. holotype. Fig. 3 *Fusinus galatheae* n.sp. holotype.
Figs. 4, 5 *Baryspira (Spinaspira) raoulensis* n.sp. holotype.

CYPRAEIDAE FROM NEW ZEALAND

By F. A. SCHILDER, University of Halle, Germany.

The recent discovery of two true Cypraeidae living in northernmost New Zealand, viz. *Erosaria tomlini* Schilder (Powell 1965, Rec. Auck. Inst. Mus. 6: 164) and *Lyncina vitellus* Linnaeus (see Powell, this issue, p. 185 provokes a review of cowrie species which have been erroneously credited to the molluscan fauna of New Zealand.

The first species mentioned as coming from New Zealand is the Central Pacific *"Cypraea" aurantium* Gmelin, quoted as *aurora* by Lamarck (1822, Anim.sans vert. 7:382) which indication of habitat has been repeated by Horst & Schepman (1899, Mus.Hist.Nat. Pays-Bas 13:200). The second species is the Hawaiian *C. tessellata* Swainson mentioned from New Zealand by Reeve (1845, Conch.Icon.,vol. 3 Cypraea No. 53).

According to Frauenfeld (1869, Verh.Zool.Bot.Ges.Wien 19, Abh.p. 864) the frigate "Novara" brought the following *Cypraea* from "Auk-land": *arabica* Linn., *lynx* Linn., *vitellus* Linn., *obvelata* Lam., *caputserpentis* Linn., and *erosa* Linn. (All are common Indopacific species, except *obvelata* which is restricted to south-eastern Polynesia). The original specimens now preserved in the museum of Vienna have been examined by the writer personally: Frauenfeld's determinations were correct, but the habitat evidently is false. In this museum the writer has discovered some more specimens also labelled as collected at Auckland by the "Novara", but evidently Frauenfeld could not determine them: they belong to *subviridis* Reeve (South-western Pacific), *errones* Linn. and *asellus* Linn. (both Indopacific).

All these "discoveries" have been rejected by New Zealand conchologists, but Hutton (1878, Journ. de Conchyl., 26:25) claimed to have seen a real *Cypraea* from "Baie des Iles" (Bay of Islands) in the Colonial Museum: he thought it to belong possibly to the Indopacific *Cypraea punctata* Linnaeus. Later on, Hutton (1880, Manual N.Z.Moll.,p.66) described the shell, but doubted it to be *punctata,* and at last (1884, Proc. Linn.Soc.N.S.Wales 9:935) totally rejected the occurrence of *punctata* in New Zealand. Then Suter (1901, Trans.N.Z.Inst. 34:214) pleaded the determination to be correct, but the indicated habitat to be false.

In his famous monograph on *"Cypraea"* Hidalgo (1906/07, Mem.Ac. Cienc.Madrid, 25) doubted the correctness of the indications of Lamarck *(aurantium)* and of Reeve *(tessellata),* but he adopted those of Frauenfeld (six species) and of Hutton *(punctata);* besides, he mentioned the Indo-Pacific *mauritiana* Linn. and *annulus* Linn. as living in New Zealand.

Rec. Auck. Inst. Mus. Vol. 6, No. 3, pp. 201-202, 14th August, 1967.

The writer saw some more species labelled "New Zealand" in various collections: in the public museums of Berlin: *depressa* Gray (leg. Krüper); Hamburg (now destroyed): *tessellata* and *walkeri* Sowerby; Vienna: *childreni* Gray (leg. Reischek) *arabica, annulus,* and *cribraria* Linn. (collectors unknown); Prague: *tessellata* and *limacina* Lamarck (both coll. Strickland); and in the private collection of E. de C. Lancaster (Lyme Regis): *maculifera* Schilder.

All these data concerning nineteen species evidently are false! Really a sad sight of the carelessness of conchologists with regard to indication of habitat!

The two recently discovered species *vitellus* and *tomlini* are the only true cowries living in New Zealand, though one would expect *caputserpentis* and *erosa* too.

The New Zealand *Ellatrivia memorata* Finlay, 1927 (=*E. maoriensis* Mestayer, 1927), which is hardly separable from the Australian *Ellatrivia merces* Iredale, 1924, must be separated from the true Cypraeidae: it belongs to the family Triviidae.

Midden Analysis and the Economic Approach in New Zealand Archaeology

By JANET M. DAVIDSON

ABSTRACT

New Zealand archaeologists are becoming increasingly aware of the need to analyse and make use of non-artifactual material in archaeological sites. New techniques are being sought for this purpose. At present, however, it is the work of a few people. The history of archaeology in New Zealand is reviewed, showing that at times in the past considerable interest was taken in this aspect of archaeology, while at other times it was badly neglected. Early observers noted the presence of kitchen middens and their significance. During the first period of intensive archaeology, von Haast and others took account of all items recovered from archaeological sites. Subsequently interest lapsed and when serious archaeology got under way again in Otago the emphasis was on artifacts and material culture. In recent years there has been a diversification of problems and approaches. The work of a few people shows what could be gained from further refinements of techniques in midden analysis and the realisation by more people of its uses and applications. A comprehensive bibliography of archaeology pertaining to excavations in New Zealand is included.

Introduction

In recent years, a few archaeologists in New Zealand have turned their attention to the careful analysis of non-artifactual remains in archaeological sites. In particular, attention has been focused on those sites such as shell middens which consist almost entirely of non-artifactual material and which have been largely neglected previously because of their lack of artifacts. At the same time, archaeologists concerned primarily with the recovery of other kinds of data, particularly structural or artifactual, have felt it necessary to pay increasing attention to non-artifactual material discovered during the course of excavation. There has been, then, a search for techniques suitable for analysing non-artifactual material, and a greater awareness of the kinds of information which non-artifactual remains can supply about ways of life in the past. The first attempts in these fields were of necessity elementary and tentative, but with publication imminent of a very detailed report on the total content of a beach midden and the kinds of inferences to be derived from it, a new stage in the development of this kind of study would appear to have arrived.

A preliminary report on this study (Terrell, 1966) suggests that while the methodology is admirable, the study fails to distinguish between different kinds of midden, assuming that the site under consideration is typical of all New Zealand middens. Previous writers, however, have endeavoured to show that the term midden has been applied to a considerable range of sites, including those which furnished abundant artifactual material, and that different techniques may be found to be suited to different types of midden (Green, 1959, 1963; Davidson, 1964). Of a total of 122 sites excavated and reported on at least briefly up to 1964, 97 were primarily refuse deposits or middens, 15 had at least some associated midden material, 7 were structural sites in which midden material is not mentioned, while only 3 were said to be altogther lacking in midden deposits.

The primary reason for the excavation of these sites was usually the recovery of artifacts. Some excavators, however, paid considerable attention to the non-artifactual material present in sites, particularly shell and bone, and the inferences to be drawn from them. Without consciously expressing it, these workers were making some attempt to deal with the archaeological dimension of the "economic approach to prehistory" (Clark, 1952, 1953, 1960: 169-218); the study of man's relationship to his environment in the widest sense. In the earliest stages of New Zealand archaeology, in particular, many theories based on non-artifactual remains were formulated which still have relevance today, although the techniques used to collect data left much to be desired.

In this paper, the history of New Zealand archaeology in so far as it is concerned with the excavation and analysis of midden deposits will be outlined. It will be evident that interest in aspects of archaeology other than the recovery of artifacts has fluctuated considerably through time, and it will also be apparent that at various stages the influence of scientists educated primarily in other disciplines has been beneficial.

In the historical survey which follows it has been found necessary to divide the total time span into a number of periods in each of which certain trends appear to have predominated. This division refers only to the particular subject under discussion and not necessarily to the history of New Zealand archaeology as a whole. The survey ends in 1958, the year which saw the first publication of the New Zealand Archaeoolgical Association *Newsletter*. The subsequent years have been characterised by a tremendous burst of archaeological activity throughout the country which is still largely unpublished. It is only since 1958, moreover, that systematic attempts at midden analysis and classification have been undertaken, and these attempts are the only research of the most recent period to be considered here.

The term midden was first introduced into New Zealand soon after its first use in England as an archaeological term, by men who were familiar with the development of archaeology in Europe, at a time when the Danish kitchen middens were still exciting interest. In 1870, Taylor included a chapter on Maori middens in the second edition of his book (Taylor, 1870: 414-423) in which he compared New Zealand and Danish middens. In 1871, Sir Julius von Haast was using the word as a standard term (von Haast, 1871). It was usually further qualified as "kitchen midden" and "shell midden" although some people talked of "Maori middens" or even simply of middens. None of these terms was used entirely consistently, although all have been widely used. A kitchen midden was any deposit of food refuse, while in a shell midden, shells constituted most of the refuse. I shall be concerned here not only with sites which have been classed as middens by people who investigated them, but with all sites containing non-artifactual or midden material.

Prelude: Before 1871

When Sir Joseph Banks was in New Zealand in 1769, he observed a number of shell heaps, including one in the process of being deposited.

> " . . . indeed wherever we went, on hills or in valleys in woods or plains, we continually met with vast heaps of shells often many wagon

loads together, some appearing to be very old; where ever these were it is more than probable that Parties of Indians had at some time or other taken up their residence as our Indians had made such a pile about them." (Banks, 1962, I : 427).

He also noted the presence of regular rubbish dumps in the villages.

"They have also a regular dunghil upon which all their offalls of food &c are heaped up and which probably they use for manure." (Ibid. : 418).

Many years after Banks other observers commented on these remains of former occupation and drew many and varied conclusions from them, without, however, investigating them closely. Taylor saw them as remains of former times of hunger (Taylor, 1870 : 419, 1873 : 99-100), while Colenso on the other hand saw,

" . . . enormous mounds of river, lake, and seashells, sometimes clearly revealing the slow accretions through years or centuries, by their accumulations having been made *stratum super stratum* with intervening layers of vegetable mould and *humus* . . ." (Colenso, 1868 : 55).

A much later investigator with an interest in middens neatly phrased the opinions of these two observers by stating that one saw them as remains of former scarcity, and the other as remains of former plenty (Best, 1918a : 84). Few observant travellers around the New Zealand coast could fail to be struck by such conspicuous deposits.

Little attention was paid to them, however, until the question of whether or not the Maori knew the moa arose. This question, and the associated disputes, led to the first burst of archaeological activity in New Zealand. But before this intensive investigation of archaeological sites got under way, there were spasmodic investigations during the thirty years following the first discoveries of moa bones.

The first sites to be investigated were that at Waingongoro in South Taranaki, which was visited by Taylor in 1843, Mantell in 1847, and again by Taylor together with Sir George Grey in 1866, and the South Island site which Mantell called Awamoa. Cormack in 1856 recovered moa bones from a site in Opito Bay (Mantell, 1848, 1872; Taylor, 1870 : 414-416, 1873 : 100; Owen, 1856).

Taylor and Mantell in their brief accounts of these sites listed the bird bone and shells which they found, and described the sites in a manner at least as accurate as that found in many brief site reports which appear today.

The investigations of these earliest years, however, were too spasmodic to lead to any consistent research. Already a number of people had observed the kitchen middens, as they came to be called, interpreting them variously, and Banks had even been so fortunate as to see one being made. On the other hand a start had been made on the investigation of deposits containing moa bone, which were recognised as archaeological sites. These few investigations paved the way for the first great era of New Zealand archaeology. Taylor suggested that investigation of the middens should throw light on the past state of the Maori (Taylor, 1870 : 419). His essay of 1870 stands on the borderline between the two periods. It sums up the findings of

the early period and sets the stage for the next scene, in which the principal actor was to be von Haast.

Moas and Moa-hunters: 1871-1900

In 1871 von Haast sparked off more intensive investigations of a number of archaeological sites with his three papers on moas and Moa-hunters, read to the Philosophical Institute of Canterbury (von Haast, 1871). It is here that we find the first attempt to distinguish between middens of different ages by supposed differences of composition. Von Haast attacked Mantell whom he considered a supporter of the "recent extinction" theory on the grounds that he had failed to perceive the differenc between Moa-hunter beds and later Maori beds which von Haast thought was everywhere observable (von Haast, 1871 : 78). He considered that the site at the Rakaia River mouth, on which he based his observations, consisted of a later Maori camp site on a lower river terrace, and the Moa-hunter site, an area of kitchen middens and ovens, on the other terrace (ibid. : 81). He noted great quantities of flint, and some obsidian, but his main concern was with the faunal material. The moa species he found to be comparable to those previously recovered from a geological context at Glenmark and in the same frequency. He distinguished also five other species of birds, some small whale and much seal. Dog was very rare. There were a few shells of *Unio* (*Hyridella*),[1] and a large marine mussel. He commented on the absence of weka bone. Two other sites were mentioned briefly, from each of which moa, seal, whale, and numerous shellfish were recovered. The specific names of the shellfish are given but an apparent difference in shell content between Rakaia and the other sites was not remarked on.

Nowhere is there an explicit statement of method, which may have been a form of surface collection. On a further visit to Rakaia, von Haast dug, and obtained more extensive information. From this he furnished a fuller description of the site, adducing more evidence in support of his theories and ending with a number of important conclusions concerning the Moa-hunters (ibid. : 94-97).

This statement aroused several dissenting voices who sought to prove that the moa was in fact far more recent than von Haast had suggested. Hector and Murison (Hector, 1871; Murison, 1871) described inland moa-hunting sites which they believed could not be of the antiquity von Haast demanded, but their descriptions are brief and no listing of faunal material is given.

The next important event was the excavation of the famous Moabone Point Cave at Sumner, results of which were published in 1874. As is well known, von Haast employed two workmen on the site, one of whom, Alexander McKay, published his own account of the excavation before von Haast. Von Haast's account was by far the more detailed and was the only excavation report of its calibre to appear for many decades. The two accounts agree in distinguishing between the dirt beds from which almost all the moa bone was recovered, and the upper shell beds, which amounted

[1]Names of shellfish cited in the text are those used by the authors concerned. Where these names are no longer in use, the current name is given in parentheses.

to five feet of interspersed beds of loose shell and ash. The shells here were from the nearby estuary, while the lower dirt bed and the upper part of the agglomerate contained bones of living and extinct animals, and almost no marine shell, although there were some *Unio* (*Hyridella*) shells. Von Haast suggested that this lack of shells could be due either to the fact that the earlier people did not eat them, or to the possibility that at the time the cave was first inhabited the estuary had not been formed, in which case the shellfish would not have been available as they were to the later occupants (von Haast, 1874a : 63).

The disagreements between von Haast's and McKay's accounts are not due to disparity in detail, but to the differing interpretations which both placed on the data. Thus von Haast, committed to his views on autochthonous Moa-hunters, considered that the cave had been occupied intermittently, first by Moa-hunters, who deposited refuse in it but rarely cooked there, and subsequently, much later, by the shell-eating people, who ate also the estuarine shells, *Chione, Mesodesma* (*Amphidesma*), *Amphibola,* and *Mytilus,* together with seal, dog, fish (mostly hapuku), and small birds, notably the spotted shag. These beds were full of European material thought to have been mixed in by rats. The lower beds contained quantities of moa bone, shag, penguin, and other birds, and dog. He was forced to concede that the Moa-hunters did have polished stone tools, but held firmly to the view that the beds were the remains of two different races of people, separated by a great period of time.

McKay agreed with von Haast that there was a time gap between the Maori and the Moa-hunter beds. He favoured a cautious interpretation of the data, however, and inclined to the view that the same race of people were responsible for both deposits. He argued that once moas became extinct, Moa-hunters would be forced to eat the same sorts of food as did the later Maori, and also that Moa-hunters could well be eating moas elsewhere, where they were still available, while their cousins were eating shells at Sumner. He was the first to attempt a tentative relative chronology of Moa-hunter camps based on the kind and size of moas killed, the types of artifacts left behind, and similar evidence (McKay, 1874).

In the same year von Haast also published accounts of a burial place near Sumner, in which he continued his account of the Sumner middens, and of the Shag Point site in Otago.

At Sumner, he concluded, a Moa-hunter burial ground had been succeeded by a Maori cooking site (von Haast, 1874b :90). Most of the middens consisted mainly of *Chione,* with *Mesodesma* (*Amphidesma*), *Amphibola,* and *Mytilus* also well represented. Seal and groper were present. One midden, however, consisted almost entirely of *Mesodesma cuneate* (*A. subtriangulatum*).

At Shag Point both Moa-hunter and Maori middens and ovens were scattered over the entire area; usually they were stratigraphically separate, the shell beds being never less than two feet above high water mark, while the Moa-hunter beds were sometimes as much as two feet below high water mark. Often a Moa-hunter bed might be situated on a sand hill, while a Maori bed rested on a lower level in a hollow. Shell in the Maori beds was mainly *Mytilus, Haliotis, Chione, Mesodesma* (*Amphidesma*) and *Lutraria* (*Zenatia* or *Resania*). Fish, dog, and obsidian were present. In

the earlier deposits, seven species of moa together with fur seals, sea leopards, and whale, were identified. Observations were made on the butchering habits of the Moa-hunters (von Haast, 1874c).

No-one ventured to challenge von Haast's interpretations on his home ground among the Sumner dunes. His statements concerning Shag Point, however, met with criticism from Hutton (Hutton, 1875) who with a Mr Booth spent some time at Shag Point the following year. He did not agree with von Haast about the greater depth of the moa beds, nor did he accept the moa bed/shell bed dichotomy. He found that deposits of shell and bone were generally only four or five feet deep although in one place a deposit was encountered twelve feet below the surface and under four feet of clean sand. Again, on the highest sand hill there was a layer containing several species of moa, fish, and an immense number of shells of *Haliotis iris*, *Amphibola avellana* (*A. crenata*), *Chione stutchburyi*, and *Mytilus dunkeri* (*M. edulis aoteanus*) together with artifacts. The deepest deposit contained seal, moa, penguin, fish, *Haliotis iris* and a considerable amount of *Chione stutchburyi*, larger than other shells of this species in the area. At each excavation the deposits were very similar. Some deposits of shell did not contain moa, but these were sometimes under moa beds. At one point moa bones increased with depth of deposit. A list of material from the site generally is given, and includes: seal, dog, rat, four species of moa, albatross, penguin, and other birds. Fish was common, especially *Thyrsites*, and shell included, *Calyptraea maculata* (*Sigapatella novaezelandiae*), *Imperator cookii* (*Cookia sulcata*), *Turbo smaragdus* (*Lunella smaragda*), *Haliotis iris*, *Amphibola avellana (A. crenata)*, *Mactra discors*, *Mesodesma novaezelandiae (Amphidesma australe)*, *Chione stutchburyi*, and *Mytilus dunkeri (M. edulis aoteanus)* (Hutton, 1875: 105-106).

Meanwhile, reports of moa bone finds in various parts of the country were appearing. In 1875, Robson the lighthouse keeper at Cape Campbell, reported moa bone, and also ovens with fish, shell, human and bird bone. He considered that these were Maori ovens, with nothing to connect them with the moa bone (Robson, 1875). The following year, however, he reported finding moa bone, seal, dog, and fish bone, pipi (*Amphidesma*) and other shells, and a few human bones, together with artifacts but no greenstone, on the spit between Lake Grassmere and the sea (Robson, 1876).

In the previous year a report of Moa-hunter sites in Northland near Whangarei was made (Thorne, 1875).

Von Haast continued his investigations, reporting in 1877 on three deposits of different ages at the site of the Weka Pass Painted shelter. Here a dirt bed with very scanty remains of ash and fine fragments of bone was located on the east side of the shelter. It contained a few moa bones, some small bird, mainly kiwi, a few shells of *Mesodesma novaezelandiae* (*Amphidesma australe*), seal bone, wood, flint, and sandstone. A similar layer on the west side of the cave contained *Mesodesma* (*Amphidesma*), *Mactra discors*, and *Mytilus smaragdinus* (*Perna canaliculus*) together with a few flakes. The two areas were separated by a European Maori layer, containing worked *Haliotis* shell, coal, metal, etc. (von Haast, 1877 : 51-53).

In 1879, he recorded a "manufactory of stone implements" at Otago which "belongs doubtless to an intermediate period when the Moa had already become extinct." (von Haast, 1879 : 151). This site at Otakai seemed

to differ significantly from the deposits at Kaikorai some six miles to the north. At Kaikorai there was a line of kitchen middens up to one foot in thickness, which contained mostly shell, *Chione stutchburyi* and *Mesodesma novaezelandiae* (*Amphidesma australe*) being most numerous, and up to twice the size of those now available in the estuary. *Mytilus smaragdinus* (*Perna canaliculus*) was present in appreciable amounts, though the shells were smaller than those now available, while *Amphibola* and others appearing in considerable numbers were not remarkable in size. Broken and burned bones were present in the deposits including scarce moa bone. There were also adzes and knives. At Otakai a trench two feet by thirty feet revealed two layers. The upper was typical kitchen midden material six to eight inches deep containing seal, dog, bird, and fish, even the smallest of which seemed to have been used for food, but no moa. Beneath it was a layer three to six inches deep resting on loess, which contained cores, flake implements, and chips from basalt beach boulders, but no polished stone, and only rare shell and bone (ibid. : 152).

While von Haast had by this time moved from his original position in several respects, the controversy concerning the date of extinction of the moa continued to rage for many more years and a number of people brought forward evidence to suggest that the moa had survived almost into the European period. One of these was W. W. Smith, who had discovered evidence of moa-hunting in the MacKenzie Country. In his first report Smith described a dry cave floor from which he recovered midden bone of kakapo, kaka, weka, pukeko, kiwi, and moa. He also located scraps of burned bone near old open camps, but was not able to find any "kitchen middens" (Smith, 1884). In a further report (Smith, 1891) he mentioned finds of pipi, *Mesodesma novaezelandiae* (*Amphidesma australe*) and Pawa (sic) (*Haliotis iris*), in a cave shelter, and also superimposed ovens in the open, seemingly evidence of intermittent occupation, one of which was brim full of mussels which had apparently never been opened. From these data, Smith concluded that the moa had been hunted until fairly recently in the area by Maori people, who he thought probably lived a seasonal life, spending part of the year inland hunting moa and other birds, and part on the coast exploiting the resources there. The next evidence brought forward in favour of the comparative recency of moa-hunting was that of Monck's cave at Sumner, the interpretation of which will unfortunately always be shrouded in uncertainty. Two brief reports of the cave are available (Meeson, 1889; Forbes, 1890) but there is no detailed account of the stratigraphy. The cave had been completely sealed off for many years by a landslide which covered the mouth, unlike the Moa-bone Point Cave which had been freely used during European times, and consequently when it was discovered, objects used by the last inhabitants were lying where they had been left. While the significance of the site was realised, no attempts to record the stratigraphic position of the finds was made, although Meeson states quite clearly that there were a number of layers varying from one or two to six or nine inches in depth (Meeson, 1889 : 67). Both observers who reported on the site were convinced that the last occupants to use the cave before it was sealed off, were people with a Maori culture, of the type known at the time of contact. Meeson even suggested that they were seasonal visitors from the North Island, and both he and Forbes were certain that these last occupants who left greenstone, and a carved canoe bailer, on the floor of the cave, hunted and killed moa, and the extinct

swan. Neither ventured to hazard any suggestion as to how long ago this last occupation occurred. While there is very little detail regarding the composition of the site in either account, the opinion was that the people had been living mainly on moa and fish. No account of shellfish is given.

The argument favouring recent survival of moa was carried to its extreme by Field, who in 1891 tried to show that the moa survived after Cook, and even into the whaling period on the coast between Whanganui and Wellington. Although he had investigated extensive middens on this coast he produced very little in the way of accurate descriptive evidence (Field, 1891a, 1891b). His views, while in accord with the account of a moa hunt on the same coast given by an old Maori at the time of the visit of Taylor and Sir George Grey to Waingongoro in 1866, were rejected by subsequent writers.

At the time, Field's views were accepted by de Quatrefages writing from Paris, who in 1892 presented a summary of the entire controversy to date (de Quatrefages, 1892). By now the question was more or less closed, with most people convinced that the moa was exterminated by the ancestors of the present Maori race, although the time when this was supposed to have taken place varied considerably.

During this period, some writers had been content simply to describe findings, leaving interpretations to others. Thus Chapman described moa bone finds in various places (Chapman, 1884) without taking part in the dispute, and Mantell, who had been von Haast's original scape goat, in a later paper tried to show that he was interested only in placing the data on record, not with interpretations (Mantell, 1872 : 97).

A few small reports in the 1890's close this phase of archaeology. Hamilton, describing inland sites in the South Island, managed in a few brief reports to find space for some account of the composition of these sites. For instance he reported on a site on the Old Man Range, where he found small fragments of moa bone, and many thousands of quarzite flakes which he considered to be smaller and different in kind from those at Shag River, which he was also investigating at this time, but which either he nor Chapman reported on in detail (Hamilton, 1894 : 238).

He was more concerned with painted shelters, however, and listed finds in the floor of one on the Waitaki River as, a worked seal tooth, three worked bird bones, cut *Haliotis* shell, three valves of *Mytilus (?Perna),* some kokowai, fragments of *Patella (Cellana)* and *Unio (Hyridella),* a thin stick and some chert flakes (Hamilton, 1896 : 173). Similar material was encountered on the floors of other caves (Hamilton, 1897 : 25).

One other worker who troubled to describe midden deposits was Joshua Rutland. While mainly interested in pits and terraced sites, he also observed and commented on kitchen middens in the Marlborough Sounds. These were numerous, dispersed, and belonged to all periods of occupation in the area. Some were situated on hills or inland, while others were coastal. In some the shell, even paua, was whole, and as pretty as fresh shells, while in others the shell was crumpled and fragmented. Some which he considered to be older yielded bones of fish, rat, and dog. A cave site yielded human bones, together with bones of fish, bird, and seal. Rutland was also concerned with the distribution of moa bones in his area, and found that the distribution

of bones, both in middens and in natural deposits, coincided with the distribution of the pit and terrace sites in which he was interested (Rutland, 1894). He later reported further finds of moa bones in middens (Rutland, 1897).

The turn of the century marked the end of an era in New Zealand archaeology in many respects. It was an era which saw some workers achieve a standard in investigation of midden deposits which was not again reached for many years.

Although the investigations concentrated on the crucial question of the Moa-hunters, it involved other questions besides those mentioned here, notably whether the Moa-hunters had polished stone tools, or whether they were still living in a palaeolithic era. Throughout this time a fierce battle also raged regarding the traditional knowledge of the moa, between those who found frequent reference to it, and those who found none. While the presence or absence of traditional references and the reasons for this were argued into this century, as was the controversy about the date of extinction of the moa, it was some time before the archaeological evidence was again consulted on the subject.

In these thirty years it is difficult to see any refinements of method, and indeed it is only rarely that we are even told whether or not excavations were carried out on a particular site. The men of the day were no doubt well acquainted with each other's methods of research and so took such information for granted. An exception is the Moa-bone Point Cave excavation, for which plans and sections were published in detail. Von Haast's passing reference to a trench two feet by thirty feet at Otakai perhaps conveys an idea of the general scale of operations. We also know that the excavations at Shag Point by Booth and Hutton were fairly extensive, as Booth spent some weeks at the site and ten boxes of moa bones were obtained for the Otago Museum (Hutton, 1875 : 104). The Monck's Cave site was completely dug over, as were many other cave and rock shelter sites in the South Island. By 1900 also, the unsystematic and unreported fossicking which has plagued New Zealand archaeology, was well under way.

It had soon become obvious that the way to obtain information was to dig, and this was done. But without a full assessment of museum collections it is difficult to know how much material was kept. Certainly moa bone and other bone of interest, together with all artifactual material, was saved. But little attention was paid to flakes, and none at all to oven stone and other unworked stone. Shell and fish bone were presumably discarded after a rough assessment of the major species present had been made.

A feature of this era was that the men who took the leading roles were scientists, and unlike many who came after them were familiar with geology and zoology and capable of identifying the faunal remains, stone, and other material which they encountered in their sites. While many of their determinations did not survive further advances in the fields concerned, this is perhaps irrelevant, because to the best of their knowledge they did identify and publish lists of species used for food by the inhabitants of the sites with which they were concerned. Thus they were interested not only in recovering artifacts, and in the question of whether or not the Moa-

hunters had polished stone tools and greenstone, but also in the economy of the prehistoric Moa-hunters. The speculations of von Haast and McKay about the lack of shellfish in the lower "dirt bed" at the Sumner Cave are an excellent example. Some of their theories have failed to stand the test of time and additional evidence, but it is now easy to sort out what is valid in their work, without being unduly disturbed by those theories. Any theory about palaeolithic Moa-hunters has now been rejected, and subsequent workers have not been able to substantiate von Haast's claims for land subsidence between the earlier and later occupations at Shag Point. Other theories have also been rejected. Yet we have from von Haast, McKay, Hutton, Robson, Smith, Forbes, Meeson, Hamilton and Rutland, descriptions of refuse deposits with some account of stratigraphy, and lists of species of birds and shellfish, sometimes with some attempt to indicate proportional representation. Von Haast put forward a hypothesis concerning two different kinds of deposit representing the food refuse of two different groups of people. In addition he made suggestions concerning seasonal pursuits represented by different kinds of midden, was aware of the significance of obsidian in South Island sites, and drew distinctions between the working floor deposit and the kitchen midden at Otakai. There were comments on the lack of food which might be expected in certain sites, notably weka, on the different size of midden shells from those presently available and on the different durability of some shells in middens. Finally, as McKay's work indicates, enough data existed to begin to consider a relative chronology of several Moa-hunter sites in the South Island on the basis of size and range of moa bones. Some inferences were even made about every day activity from the distribution of remains in the site, as for example, the suggestion that cooking took place on the area immediately outside the Moa-bone Point Cave.

In short, during this time a start was made on a number of problems which are still of interest today. While the excavation technique was dubious, and sampling and quantification were unknown, one can see an awareness of the sort of information other than an artifactual sequence which could be gleaned from sites of this kind, particularly with regard to primitive economics. There was no consciousness of this as a branch of archaeology, rather this *was* archaeology as it was known at the time. Little doubt attaches to the fact that the man responsible for this early flowering of New Zealand archaeology was von Haast, who with his knowledge of old world archaeology and his attempts to introduce concepts therefrom into New Zealand, sparked off a number of controversies which raged fiercely side by side with the existing one of whether or not the Maori knew the moa. As these issues waned, so did the interest in and the enthusiasm for archaeology.

The Lean Years: 1900-1923

From the time of the founding of the Polynesian Society in 1891, until the rebirth of archaeology in Otago in the 1920's almost no work was done with middens except for the few small reports during the '90's discussed above. The great part of the anthropological effort turned in other directions, towards traditional and ethnological material, and away from archaeology. Moa traditions continued to excite interest and several more papers appeared on this subject. One rather belated addition to the discussion of the previous

thirty years was a paper by Hill (Hill, 1913) summarising the earliest material, and claiming that while three sand beds existed on the East coast of the North Island, the lowest of these only contained moa bones while it is the middle bed that contained the human midden material consisting of obsidian, walrus, fish and human bone, and shells, Hill claimed that in many years on the coast he had never found moa bone in primary association with the middle sand bed (Hill, 1913 : 343).

It was during these years that pioneer work was being carried out in Californian shell mounds by Gifford and Nelson, while other work had already been done on similar deposits elsewhere in the United States. The pioneering work of Gifford and Nelson was to be taken up much later by other archaeologists in California, who were to develop many techniques of midden sampling useful today. Gifford later applied the techniques he had developed in California to sites in Fiji, New Caledonia and Yap. Unfortunately these early excavations of Californian shell mounds passed unnoticed in New Zealand, where old world archaeology had previously provided such a stimulus. Instead the archaeology of this period was largely field archaeology, or the recording of place names and earthworks. Fossicking proceeded unrestrained in many areas, but few records were made, and those that were kept were generally concerned only with the curios recovered (e.g. Christie n.d.). One of the principal fieldworkers at this time was Elsdon Best, who in addition to his ethnological work managed to amass a large amount of information on the field archaeology of the Wellington district, and on pa sites throughout the country. A curious by product of his activity was two small papers on the shell middens of the Wellington and Porirua Harbours. He followed the prevailing practice of neglecting to make any statement of his method of investigation, but as he records twenty-seven species of shellfish from a midden at Onehunga on the south side of the entrance to the Porirua Harbour, one must conclude that his investigations were fairly extensive. There is nothing to suggest that Best's interest in middens derives from the work of Gifford and Nelson a few years before, rather than from his own insatiable curiosity, and desire to record everything he could. His remarks on these middens are interesting, as he points out clearly the differences in content, without drawing any conclusions.

Around Wellington, he stated, the population must always have been small as there was little scope for kumara growing, and therefore there are no large shell heaps such as occur elsewhere in the country. Most are talus middens — thrown over the cliff by the Maori housewife. Already in 1918 the best ones had been obliterated. The most important food on the outer coast was fish, followed by shellfish. At Tarakena all shells were univalves, the extreme rarity of mussel being explained by its poor durability. On the outer coast also there were very few *Chione:* evidence against visits to the harbour. In this area oven stones were sought after and traded, and evidence of this was to be expected in middens (Best, 1918a).

Porirua offered more scope. Five areas of large midden were considered to be permanent village sites, while numerous small middens offered evidence of temporary halts (Best, 1918b). Several interesting differences presented themselves. At Titahi Bay, on the outer coast, one midden consisted almost entirely of *Amphibola crenata,* available only in the harbour, while one very close to it had almost none of these shells. At Onehunga, where the

twenty-seven species were found, the position of the site at the entrance to the harbour was reflected by the presence of shells from sandy, mudflat, and rocky environments, but shells of *Astraea sulcata* (*Cookia sulcata*) common elsewhere in Porirua were absent. At Onepoto, source *par excellence* of *Amphibola crenata,* none of these shells was found in the two middens, one of which contained nearly all *Chione stutchburyi,* and one almost all *Mesodesma* (*Amphidesma*) *australe.* These two middens were only a couple of chains apart, and a similar situation was observed at Paekakariki, where one midden was almost entirely *Mesodesma* (*Amphidesma*) *subtriangulatum,* and one close by was almost entirely *Dosinia anus.* At Paekakariki there were many middens in an extensive dune area from which Augustus Hamilton was stated to have recovered 100 stone adzes. Best found that these middens varied in composition and state of erosion, but could be divided for the most part according to content into those consisting mainly of *Mesodesma* (*Amphidesma*) *subtriangulatum,* and those consisting of *Dosinia anus.*

The main points of interest arising from Best's brief paper are the interpretation of five sites as permanent villages on the grounds of size (these five were also the most profitable in terms of artifactual material), and the fact that the distribution of shellfish in the middens did not correspond to the distribution of shellfish in the harbour. An equally important point is the different composition of closely adjacent middens, both at Porirua and at Paekakariki, a point which occurs again and again around the New Zealand coastline.

Best's excursion into midden analysis, although it stands alone in an otherwise barren period, and was still entirely lacking in technique of excavation, shows that interesting information can be obtained by a survey of middens in a fairly small area. It also raises one of the basic problems which face all investigators of shell mounds throughout the world, and one already foreshadowed in New Zealand by the Moa-bone Point Cave excavations. The question is whether change in shell content is due to changes in resources available owing to natural change or over-exploitation, or to change in cultural preference. It is a question which has to be faced anew in each new situation in which it arises. Best did not attempt to answer it, but contented himself with placing on record differences which he observed in sites which were even then disappearing, many of which are now completely lost.

Unfortunately few of Best's contemporaries shared his interest in middens, or his desire to place these insignificant sites on record, and it was some years before the next phase of archaeology which was somewhat differently oriented, got under way in Otago.

The Otago School: 1923-1940

The finding of the teachings of Te Whatahoro and the theories of Best and Smith regarding a Maruiwi people, stimulated the next burst of archaeology in New Zealand. In 1923 and 1924, H. D. Skinner re-examined the materials from the two caves to find archaeological evidence which would support or refute the Maruiwi hypothesis. He was unable to draw many conclusions concerning Monck's Cave, although he found the material culture there more interesting (Skinner, 1924 : 151), but he reached

a number of conclusions concerning Moa-bone Point Cave. In it he found no evidence that the earlier inhabitants belonged to a culture resembling that associated with the traditional reconstruction of a Maruiwi group of people, adopted the explanation that the foreign moa bone in the upper beds was due to fishhook manufacture, and was not convinced by the claims for a *Dinornis* association. Most interesting is his attempt to assess age by rate of accumulation, a technique popular elsewhere in the world, but otherwise neglected in New Zealand. In spite of the differences in the nature of the Moa-hunter and post-Moa-hunter deposits in the cave, Skinner assumed that the rate of accumulation would be the same, and that therefore the upper beds represented a period seven times as long as the Moa-hunter period (Skinner, 1923 : 103)

Meanwhile Skinner prevailed upon David Teviotdale, who had been digging at Shag River (von Haast's Shag Point) for ten years, to write a report on his activities there. This first report mentioned a number of midden areas and bone beds, some of which had been turned over by previous investigators, but gave no details of composition. The deposit varied from a few inches to two and a half feet in thickness and was much deeper at one or two spots (Teviotdale, 1924).

Next Teviotdale reported on a cave at Taieri River mouth with two main layers, containing mussels, some paua, a few pipi, and fragments of moa bone in the lower layer. Shells seemed to have been cooked and thrown to the back of the cave (Teviotdale, 1931 : 89).

Then came an assessment of the material culture of the Moa-hunters as it was then known (Teviotdale, 1932), in which ten sites, including both hunting sites and permanent settlements which Teviotdale had dug on were compared, together with some worked by previous investigators. All the evidence then available for Moa-hunter sites in Murihiku was assembled and a comparison of moa bone from Awamoa, Rakaia, Moa-bone Point Cave, Sumner dunes and Shag River was made. In his assessment Teviotdale found no evidence for the postulated Maruiwi culture. He also concluded that while Shag River, for instance, was a permanent settlement, with remains of many other kinds of food besides moa, the large camps at the mouths of the Waitaki and Rakaia Rivers were hunting camps where moas were slaughtered. He suggested that Moa-hunters lived in the north of the South Island and made annual excursions further south for moas. In his view the eating of eggs would be an important factor in the extinction of the birds. As only slight differences could be distinguished between north and south Murihiku sites, and all had Polynesian parallels, he concluded that all Moa-hunters were of Polynesian origin. All had the oven, the dog, obsidian, and greenstone.

In the next eight years Teviotdale published a series of papers on the Papatowai site at the mouth of the Tahakopa River. At Papatowai, several different areas were worked. In most places a shell layer overlay a black layer, but with the exception of one area, considered to be post-Moa-hunter, food moa bone was discovered in both the black and the shell layer in all localities (Teviotdale, 1937, 1938a, 1938b).

The different localities at Papatowai were each described briefly with a list of the three or four common shellfish by common names, also noting the presence of dog, seal, moa, and other birds, again by common names.

There appears to be considerable variety between layers and localities, although Teviotdale was careful to emphasise that food moa bone was present at all localities except one. Thus for different parts of the shell midden we are given: pipi, mussel, cockle and paua (Teviotdale, 1938a : 29) pipi, mussel, paua, and periwinkle (ibid. : 28) pipi and cockle with some paua (Teviotdale, 1937 : 137), and so on. Whether this is due to carelessness or whether the differences are in fact significant, there is no way of telling. Possible differences in bird bone from the different localities go unmentioned. Even though lists of numbers of individuals of the various moa species from the total site are available (Teviotdale, 1937 : 151, 1938a : 32) no details by locality and layer are given. However in the second report there is also a table of presence and absence of moa species from several different areas at Papatowai and at the Waitaki River Mouth site (ibid. : 34). Throughout the development of New Zealand archaeology, attempts have been made to compare the range and number of moas from sites, owing no doubt to the disproportionate interest of archaeolgists in man's association with the moa. This contrasts with the failure to make comparisons for other faunal material, or even to publish species lists of other birds or shellfish, in order to make comparison possible.

Teviotdale's experience at Tarewai Point dealt with a site of a different type from the others, which had been excavated largely to refute the Maruiwi hypothesis. Tarewai Point was a late site of early European date; a village which appeared to have been destroyed because of an epidemic (Teviotdale, 1939a : 108). He found one midden which contained "the usual shells", fish bones and scales, bones of dog, seal, and bird, and ashes. There are no further details, and Teviotdale does not mention any difference between this midden, which was evidently a specific rubbish heap associated with a village on which the house sites were clearly marked, and the others with which he was familiar.

Finally Teviotdale reported on his excavations at the Waitaki River mouth site (Teviotdale, 1939b). Here he found tremendous amounts of moa and an almost total absence of any other refuse. There was occasional seal, dog, and bird bone, and a few tools. Teviotdale's view that the site was a hunting base only was reinforced, and he further deduced that it was occupied after the breeding season, owing to the great scarcity of egg shell in the site.

The year 1940, which saw the publication of Lockerbie's King Rock report, was hailed by Skinner as the beginning of a new phase of Murihiku archaeology (Skinner, 1960 : 188), and it seems appropriate to consider it here as the beginning of a new era. It marked the beginning of a diversification of problems and approach in the archaeology not only of Murihiku, but of the entire country, although some of what followed was a direct continuation of what had gone before. The excavations of the twenties and thirties were concerned more with the portable material culture of the inhabitants of Murihiku, and their Polynesian affinities, and with a more rigorous approach to the association of man and moa, than with other features of the economy. Consequently one does not find in Teviotdale's reports the detailed species lists of earlier times, nor, apart from the inferences concerning seasonal moa-hunting, are there any new theories based on non-artifactual evidence, or any further elaborations of those

already put forward. In this respect the period marked a retrogressive step, although in other fields important gains were made.

Moa-hunter Revival: 1940-1958

In 1940 Lockerbie published a report on the site at King's Rock (Lockerbie, 1940), in 1942 Duff published his first report on the Wairau Bar (Duff, 1942), and the suceeding years were marked by the work of these two. During this period some minor South Island excavation reports also appeared, along with information on artifacts recovered from the North Island swamp pa at Horowhenua and Oruarangi, and some more specifically midden reports from the North Island.

Lockerbie interpreted King's Rock as a satellite of the larger camp at neighbouring Papatowai. Although a detailed account of the excavation technique employed was given in the report, there is no indication of how the assessment of shell content was reached. A list of birds, several of which are now extinct or not locally available was provided (Lockerbie, 1940 : 406), and also a list of the eleven species of shellfish found in the site, all of which were available locally. They were arranged "quantitatively" giving both specific and common names. Some fish was identified and fish was stated to be not as common as expected (ibid. : 407).

This excavation was the first of a number carried out in Murihiku by Lockerbie, on the basis of which he has described in general terms the change in economy with the decline in moa-hunting (Lockerbie, 1958, 1959). Unfortunately the rest of his sites have yet to be described in such detail as this first one.

The Moa-hunters of Wairau was only a preliminary to the major work which succeeded it (Duff, 1950). In it, however, the important statements concerning the Wairau middens were all made. The first report and the subsequent one were primarily concerned with defining the Moa-hunter period of Maori Culture, and the Wairau middens were seen as only incidental to this purpose. The site covers a very large area. A large portion of the excavation was in the burial ground. Here stratigraphic evidence showed that after initial use of the area adjacent to the main camp as a burial ground it was reoccupied as a cooking area by people who still hunted moa on a large scale, and who laid down a midden layer of moa bone and shell over the burials (Duff, 1942 :5). The midden contained moa bone, and also bones of swan, eagle, various other birds, seal and dog. The principal shellfish were *Amphidesma australe, Chione stutchburyi,* and *Mytilus canaliculus* (*Perna canaliculus*), the average size of the two former being greater than the average size of present day specimens in the area (Duff, 1942 : 3, Ed.'s footnote). A few middens on the bank which lacked moa bones were noted to have smaller *Chione stutchburyi,* many *Amphibola crenata,* and a few oysters.

In the subsequent report this information was much expanded. The different nature of the deposits in different areas of the site, notably the cooking area, the hut sites, and the burial ground, was emphasised (Duff, 1950 : 27). The author was now not so sure of the stratigraphy in the burial area and the relationship between the burials and the various midden layers. At this point the principal shells from the Moa-hunter middens were stated to be cockle, pipi, and reef mussel, with a few paua, probably from

Port Underwood. There was some evidence that small deposits of periwinkle were of later date (ibid. : 29). Moa was mainly *Euryapteryx*, with a few individuals of a smaller genus, probably *Emeus*. In addition there were bones of *Chenopis, Harpagornis*, and *Corvus*, together with tuatara, dog, rat, seal, and whale (ibid. : 31).

The earlier report was accompanied by a paper by Falla on bird remains from Moa-hunter camps, in which "a general sample" of bone from Wairau was discussed with reference to the Sumner Cave and Shag Point (Falla, 1942). This paper, although brief, indicates the comparisons and conclusions possible from even the limited information available at the time.

For several years after 1942 little information appeared concerning midden deposits. A series of excavation reports by Griffiths and one by George (Griffiths, 1941, 1942b; George, 1944) are illustrative of the kind of excavation which pays little if any attention to the faunal evidence contained in the middens in which excavation took place. As is common in New Zealand, the presence or absence of moa bone was considered extremely important, but other bone was mentioned briefly and shellfish hardly at all.

At this time also, a series of reports by Rolston concerning an artificial island pa at Lake Horowhenua appeared, and a report by Skinner and Teviotdale on the excavations on a similar pa, Oruarangi, in the Thames area (Rolston, 1944, 1947, 1948; Skinner and Teviotdale, 1947). From neither site is the information particularly useful, but as these and similar sites raise special problems, the data are worthy of further consideration. Rolston's reports deal mainly with the artifacts recovered. In his first paper however he described the site as consisting of two main layers, the lower one loose whole shell with no artifacts, and the upper a more consolidated layer of broken shells mixed with ash, earthy peat, and other debris. He concluded that the first layer was deliberately deposited to build up the level of the site, while the upper layer represented the debris of the actual occupation of the site (Rolston, 1944 : 165). From the nature of the artifacts and other material in the layer he inferred that the site had been used as a place of residence rather than as a retreat in times of emergency (Rolston, 1947 : 265). The shell in the site was mainly kakahi (*Hyridella*) from the lake, though *Spisula aequilateralis* and *Dosinia anus* were present together with some *Chione stutchburyi* and two much decomposed shells of *Haliotis iris* (Rolston, 1944 : 163). There was a considerable amount of stone, mostly cooking stone, and some lenses of ash and sand. Very little obsidian was present although a nearby coastal midden yielded considerable amounts, also "blackstone" and flint. While further excavations on the lake pa did not contribute materially to this information, a few more shells were noted (Rolston, 1947).

At Oruarangi a similar situation was encountered. The site had been deliberately built up by the deposition of the shells, stones, and midden refuse to a depth of four feet above the mud, so that the lower levels contained very few artifacts and were not investigated by the labourers hired for the work (Skinner and Teviotdale, 1947 : 341).

In 1948 a study which recalled the earlier midden papers of Best appeared. This is the section on middens in Adkin's *"Horowhenua."* The twenty-five page section on middens contained a number of important

hypotheses. In the established New Zealand tradition, no statement concerning the method was made, although it was claimed that the classification of these middens was the result of years of study and critical analysis (Adkin, 1948 : 39). Shell middens extend along the dunes from the Rangitikei River to Paekakariki, but Adkin confined himself to three areas in the vicinity of Horowhenua, the most important of which was that between Horowhenua and the sea. Here two belts of middens were distinguished, an older one 30 to 100 chains in from the fore dune, and a younger one extending along the beach about a quarter of a mile inland from the fore dune. The younger group contained loose scattered masses of pipi (*Amphidesma subtriangulatum*) and tohemanga *(Longimactra elongata)*, almost no artifacts, lots of waterworn pumice and driftwood. The older belt however, were compacted sites which resisted disintegration, consisting of pipi, tipatipa *(Dosinia anus)* and kaikaroro (*Spisula aequilateralis*), often seemingly useless kinds of mollusca, and no tohemanga. Pumice and timber were absent and there were far more oven stones. The shells were in a better condition which was attributed to a different method of opening them. A number of artifacts of stone and bone and quantities of chips of "blackstone" and flint indicated manufacture on the spot. These earlier sites were interpreted as centres of community activity, whereas the younger ones were thought to be just refuse heaps indicating a single phase of food gathering. Adkin was convinced that they were left by two different groups of peoples, the earlier people probably being there at a time when the shoreline bore the same relationship to their middens as did the present shore line to the later ones (ibid. : 40).

In the other two localities, a similar situation prevailed, and at places older middens were in linear relationship leading inland, which Adkin saw as evidence for shelling of food along well defined routes, although this interpretation does not seem consistent with an interpretation of older middens as community centres. A few middens were much further inland, and these tended to consist more of kakahi *(Hyridella)*. Only one pa and one kainga were located with midden definitely associated. A list of the articles occurring in the older middens in their appropriate order of abundance was given although the method by which this list was compiled was not described. Presumably it was a subjective estimation.

While we lack information on the methods of analysis employed and the field data on which the conclusions are based, the work nonetheless raises a number of interesting possibilities concerning middens. Later in the book, the presence of stone working evidence in a shell midden is listed as a criterion of Waitaha occupation (ibid. : 120), the Waitaha being in Adkin's view the earliest occupants of the country and one of the two groups of people who hunted moa in the Horowhenua area. This criterion has since been challenged by Golson (Golson, 1960 : 383). Another of Adkin's criteria for early occupation, that of ovens with moa bones, has been widely used by other writers as evidence of New Zealand's earliest inhabitants whether they are known as Waitaha or by another name.

In subsequent papers Adkin presented further information. The first (Adkin, 1950) dealt mainly with artifacts although a brief description of an assemblage of artifactual and other material from the Paremata site is of particular interest. Again no information was given concerning the method

of obtaining these data, which were presented as an assemblage, and include a list of shell fish in approximate order of preference.

A paper on Palliser Bay showed less concern with middens although some interesting sites were described (Adkin, 1955).

At this time two brief excavation reports again illustrated the beneficial influence of men from other disciplines in archaeology. Dawson and Yaldwyn, reporting briefly on burials at Long Beach, Otago (Dawson, 1949, Dawson and Yaldwyn, 1951), furnished very full lists of species of mollusca and birds in the overlying midden, together with a clear account of how this information was collected, and a discussion of the stratigraphic problem and the problem of moa association. These reports, in providing a full list of faunal material put most archaeological reporting to shame. Another brief excavation report in this line was that of Blake-Palmer on a small site at Seacliff, in which a list of bird species is given along with the four most common species of shell fish (Blake-Palmer, 1956). Of similar calibre also is a report by Trotter on a Moa-hunter site at Waimataitai in which full lists of faunal material from the lowest of three layers were given. Differences between midden shell and present species were noted. The method of excavating by loosening, breaking up, and washing through a fine sieve was described (Trotter, 1955:295).

Far less informative is a further report by Griffiths resembling his earlier ones (Griffiths, 1955), and contrasting unfavourably with the four mentioned above. A report on the much disturbed Murdering Beach site does not mention faunal remains at all (Bell, 1956). A further excavation at Papatowai by Lockerbie confirmed Teviotdale's observations but provided no new information on faunal or other material (Lockerbie, 1953).

A thorough report by Duff on an important find of a later Moa-hunter encampment in Notornis Valley (Duff, 1952) illustrates how small the amount of cultural material in an archaeological deposit may be.

The increasing awareness of the presence of stratigraphy in New Zealand archaeological sites is shown in a paper dealing with stratigraphy in Otago sites by Lockerbie (Lockerbie, 1954). He outlined the stratigraphy of a number of sites which he later used to document the economic and artifactual sequence in southern New Zealand (Lockerbie, 1958, 1959). Evidence for changing composition of layers is present but is not highlighted.

In the North Island the emphasis continued to be on field archaeology rather than on excavation. An interesting midden of a specialised kind was reported by Taylor at Waimamaku, where Polynesians left evidence of heavy exploitation of a particular resource, mussels. In an area still noted for its mussels today, a midden consisting almost entirely of mussel shells was located (Taylor, 1955).

A further contribution to the data on middens on the West Wellington coast was made by Beckett in a short note on middens at Paraparaumu (Beckett, 1957). He suggested that these middens were not permanent habitations but fishing and food gathering camps of people whose permanent habitations were inland, as they lacked variety and contained very few artifacts. Four typical sites were described, all close to Paraparaumu. Two

consisted almost entirely of *Amphidesma subtriangulatum*, one almost entirely of *Mactra discors*, and a fourth contained moa bones and oven stones. Only one of nine pa located in the area had an associated pipi midden. Numerous very small deposits of shell with a few oven stones were interpreted as temporary halting places of very small parties.

Beckett also furnished a brief account of the Taupo midden at Porirua which he had investigated many years before. This was one of Best's five village sites. There is brief mention of faunal remains (Beckett, 1955).

The strong interest in middens around Wellington is reflected also in a paper by Palmer filling in the data for these sites on the East side of Wellington Harbour, an area not covered by Best. Lists of contents and some sections for the few middens in the area are given (Palmer, 1956).

A brief report by Davis on the Castle Point area gave the main constituents of middens there and commented on the great size of *Haliotis* shells (Davis, 1957).

In Auckland, a description of sites in the Waitakere area mentioned middens associated with pa, and in the numerous caves of the area (Diamond, 1955).

The varied work of this period does not lend itself to easy generalisations. Two lines may be indicated, the increase in detail in some excavation reports, as for example the King's Rock report, and the work of Adkin and Beckett in recording the middens of the Horowhenua coast, and indicating the differences which occur in this extensive dune area. Throughout the period too there were a number of summaries and more general discussions, from the renewal of the discussion of moa species in southern sites, brought on by the finding of a moa egg at Shag Point (Skinner, 1941; Griffiths, 1942a) to a number of papers by Duff (Duff, 1946, 1956).

Unfortunately some of the excavation reports do not measure up to Duff's Te Anau report, where all finds were recorded, or the King's Rock excavation in description of non-artifactual material. At Wairau the prime interest was not in middens, but the great emphasis placed on the role of moa and other extinct birds in the economy, and the fact that middens of varying composition were present in the site, would make desirable the evolution of some form of sampling to document more fully this variation.

Finally the reports on swamp pa indicate the presence of a new kind of midden in the country. As yet no systematic attempt had been made to distinguish between different kinds of midden other than the ill-fated one of von Haast, until Adkin listed the midden with manufacturing material as a criterion of the Waitaha people. It is obvious that in dealing with the swamp pa, in addition to the midden associated with the habitation of a pa, a deposit consisting of deliberately laid midden and possibly also beach shell is to be expected.

Thus we have a number of hypotheses emerging again based on evidence contained in middens. Artifacts are said to be found in the upper levels of swamp pa which constitute the debris of everyday life. They are also to be found in the middens of the earlier denizens of the Horowhenua coast, which are situated further back on a prograding coast line, while

the later middens are shell dumps only, indicative of a different people and a different way of life. Both here and at Paraparaumu middens are noticed to be of markedly different composition, recalling the earlier work of Best.

At Wairau earlier middens in addition to containing a wide range of extinct birds contain a range of shellfish larger than those of the present day, and different from those of later middens. At King's Rock, on the other hand, the shellfish were the same as today but a number of birds extinct or not presently available are present in the midden.

Midden Analysis: 1958-1966

The last few years have been marked by the appearance of a number of summaries of research but very few site reports. There has also been the development of the first attempts to apply systematic, and particularly quantitative methods of analysis to midden deposits.

The first systematic sampling and quantitative analysis techniques were introduced by Green at Tairua, and there it was realised that different techniques should be adopted to analyse the shell content of the two cultural layers present in the site. Every separate and identifiable piece of shell in layer 2 in three of the five excavated squares was counted, while only a sample of shell from layer 6 in one square was taken (Smart and Green, 1962 : 247). The position of every piece of bone, stone, and artifact was noted (ibid. : 245) and these items were tabulated. The percentage by number of each shell species in each layer was calculated.

Green has attempted to distinguish certain categories or types of midden. He first discussed beach middens on the Coromandel coast, commenting on the differences between the majority of concentrated shell heaps, and deposits such as the lower layer of N44/2 (Tairua), and also noted that the middens associated with pa sites on this coast seemed to contain a wider range of shell than the beach middens (Green, 1959; Jolly and Green, 1962).

More recently he sampled and analysed fifteen dry land shell middens in the Kauri Point area, and again distinguished clearly between beach middens, middens associated with pa, and dry land shell middens, noting several differences between isolated shell middens, and middens which are actually within an area of settlement (Green, 1963 : 147).

In the Kauri Point study a 500 gm. sample was taken from each of the original samples, and analysed according to a minimum procedure considered necessary. It was demonstrated that shells of *Amphidesma australe* ranged from less than 15% to over 90% of the total shell content by weight in individual middens, while *Chione stutchburyi* ranged from less than 1% to over 80%.

Further work on the Kauri Point middens, however, suggested that the range of variation between different areas of a single midden was as great as that between different middens, and that any ordering or comparisons based on single small samples would be unreliable (Davidson, 1964b).

An ambitious midden sampling project was carried out by Smart in the Waikanae dune belt in which 111 samples were taken from 67 middens.

On the basis of this sampling an admirable set of recommendations concerning midden sampling and analysis was formulated. No evidence was produced, however, to show that the procedures recommended were necessarily more valid or useful than any others. Nor was it demonstrated exactly what purpose the procedures were intended to serve.

This work was criticised by Ambrose in a brief paper setting forth his own views on midden analysis, derived from considerable unpublished work on the midden associated with Kauri Point pa. He made the important point that middens in New Zealand are so varied that it is inconceivable that one technique could be found which is applicable to all if them. He pointed out the need for analysis of their structure, and the importance of variation in composition as a reflection of ecological or cultural change (Ambrose, 1963 : 156). He claimed that individual shells should be measured in an attempt to perceive a picture of the shell population structure which would then lead to inferences concerning environmental changes or changes in cultural preference (ibid. : 157). Great care would then be needed to ensure that the samples provided an accurate reflection of the total composition of the midden. This approach proved very valuable when the shellfish living in the vicinity of the site today were few (Terrell, 1966 : 151), but the immense number of shellfish in the Tauranga Harbour made such an approach to the Kauri Point middens more complicated.

The next development was a review of the whole question of midden analysis in New Zealand, in which the inferences to be drawn from the data obtained from midden deposits were discussed and various techniques which had been, or could be applied to New Zealand sites were assessed (Davidson, 1964a). The need for further investigations and experiments with all kinds of middens was stressed. The exhaustive investigation of one kind of midden by Shawcross and Terrell (Terrell, 1966) is a further important step, but similar detailed studies of other kinds of midden are badly needed.

A number of excavation reports from the South Island in recent years have also reflected a growing interest in midden analysis.

A report on a quartzite source site gave the number of flakes and cores from an excavated area, the first time such data had been published (Trotter, 1961). Brief preliminary reports on sites in the northern part of the South Island (Mason and Wilkes, 1963a, 1963b; Mason 1963; Wilkes et al., 1963) also reflect increasing interest in the content of middens in that area, and important advances in the analysis of stone in archaeological sites.

An important study on D'Urville Island (Wellman, 1962a) used evidence from middens to draw a number of inferences concerning the prehistoric occupation of the island. The older middens, predominantly on the Western side of the island, contained abundant moa bone, rare obsidian, and numerous flakes of baked argillite, while the later sites, situated in exposed places with good views against attack, contained abundant barracouta bones, only normal amounts of flakes, and no moa bones. In a few instances both layers occurred in a stratified context. Assuming a constant rate of geological deposition and using the evidence of pumice in the sections, Wellman dated one layer at about 1000 A.D. and the other at 1500 A.D. From the evidence of the middens Wellman concluded that the early people hunted moa, traded extensively in baked argillite, grew kumara, aud were

more numerous than the later people who had no moa, did not trade in stone, and were probably harassed from the north. A higher number of dogs per head of population than on the mainland was inferred from the number of dog bones in the middens. The total number of adzes produced by the early people was estimated as not less than 15,000. A study such as this is an interesting example of the inferences which can be drawn from an investigation of middens in a limited area. In this case no detailed analysis or sampling was carried out, and the conclusions are based merely on inspection of the sites, and careful surface observation of several hundred foot squares.

Wellman later applied his method of observing middens to 50 coastal sections around the North Island in an attempt to produce an overall summary of New Zealand prehistory from such data (Wellman, 1962b).

The work of this most recent period cannot be fully assessed until more of it is published. It may be that some as yet unpublished excavations will contribute greatly to the advances in the field of midden analysis and interpretation. Certainly there have been important developments in recent years in this field, though only a few archaeologists have so far contributed. Wellman's work, while many would not agree with it, does illustrate the kinds of information which may be gained from the study of midden deposits, and again reflects the useful contribution which can be made by one who is not primarily an archaeologist.

Conclusions

The above review of New Zealand archaeology has dealt only with those investigations which were concerned wholly or partly with refuse deposits. Yet most of the important developments in New Zealand archaeology, with the exception of unpublished excavations of recent years, have been covered, because most of the excavations have taken place in midden deposits, whether or not any attention was paid to them as such. This is clearly demonstrated in Table 1, in which all excavated sites for which there is some published material available are classified according to the importance of midden material in their composition. The overwhelming majority are primarily refuse deposits.

TABLE 1

EXCAVATED SITES ACCORDING TO IMPORTANCE OF MIDDEN

Type of site	No. in N.I.	No. in S.I.	Total
coastal midden deposit	30	40	70
inland midden deposit	1	11	12
midden with burials	—	4	4
cave with midden	3	8	11
swamp	2	—	2
pa with midden (extensive)	5	2	7
pa with some midden	5	—	5
kaainga[1] with some midden	1	—	1
pa, midden not mentioned	4	2	6
pit site, midden not mentioned	1	—	1
pa, no midden	2	—	2
kaainga, no midden	1	—	1
total	55	67	122

[1]kaainga: undefended pit complex

It is thus apparent that a very large amount of New Zealand archaeology so far has taken place in midden deposits. While it is likely that for the next few years emphasis will continue to be placed on sites with structures rather than on those with portable artifacts, many of these will also contain considerable amounts of midden material which must be analysed if the full amount of information is to be obtained from the site. Systematic analyses of midden deposits have so far been few, and the work of a very few people. They have tended to show the variety of types of midden deposits, and the need for constant experiment and further work, rather than to provide definite conclusions about middens. There is still a vast field of research awaiting investigation if the various hypotheses concerning midden deposits which have been advanced over the years are to be substantiated or disproved by a solid body of evidence carefully collected. Moreover all archaeologists must be aware of the importance of non-artifactual material in excavated sites, and of the need to study every item which occurs in an excavation, if a large and important body of material is not to continue to be ignored and wasted.

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MAORI WOOD SCULPTURE: THE HUMAN HEAD AND FACE

By GILBERT ARCHEY

ABSTRACT

A review of carvings of the human head and face, naturalistic and stylized, with seventy-six photographic illustrations arranged to demonstrate the variety and quality of art forms achieved by Maori *tohunga whakairo,* carving experts; a second part of fifty-seven line drawings arranged by locality considered as evidence in relation to art style-areas; a brief tentative conclusion as to Maori art sources and development.

Although contributed as 'in continuation' of the writer's series of studies on the separate elements and compositions in Maori wood-carving*, this paper on the human head and face should obviously have been almost the first. The order of appearance, or lack of order, has been due to the availability from time to time of subject material and to slow progress in ascertaining provenance. The latter is still imperfect and may never be bettered for, as always with early acquisitions of Maori carvings, there are all too many with no record other than "New Zealand".

As a cursory survey of the illustrations will reveal, the natural form, although almost invariably sculptured with confident competence, and occasionally with the appearance of successful portraiture, had but a small share of the wood-carver's endeavour; stylization is dominant. A primary influence in this direction might have been the natural representation of ornament — of facial tattooing, (Plate 39) which, used as it was as an emphasis of facial expression, may well have become the design framework for the stylized mask.

The present paper comprises two sections. In the first, a study of art form illustrated by photographic plates, faces and masks are arranged in groups, not that the Maori would have thought of his art in this way. He did not see the elements of his many designs as set in order on shelves, to be taken down and fitted in to this or the other setting. Each form as it were arrived in his mind as the composition of his proposed *pare* or *waka huia* developed into what was true creative design. Whereupon, as we survey the whole field that fortunately is preserved, we observe not groups so much as continuous variation, of nuances in this direction and of detail in that, ranging from naturalism to stylization, from bare austerity to complex ornament. This however is not to suggest that there is some kind of evolutionary trend, except in so far as a carver would go, or his design purpose would take him, a little further in some direction or other. And this is what we should expect from artist-craftsmen imbued with the idea of form and a feeling for design. I am confident in suggesting, as I have done previously, that, within the range of his customary practice, any one *tohunga whakairo* could have produced any or all of the "stages" one seems to recognise, as he could also have created new forms of his own.

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* *Tiki and* Pou, 1958; *Taurapa,* 1938; *Tauihu* 1956, Pare of Human Figure composition, 1960; Spiral-dominated Compositions in Pare, 1962.

Rec. Auck. Inst. Mus. Vol. 6, No. 3, pp. 229-250, 14th August, 1967.

It is desirable to state this at the outset lest the adoption of a convenient arrangement for description should give the impression of a classification. Classification or grouping will come into discussion later, in the second section, on the question of Maori art regions; but here again, with so many uncertain localizations and with awareness of Maori propensity for travel, either with friendly or with hostile intent, one may well hesitate to define boundaries, or to make, too readily, locality attributions from style.

NATURAL REPRESENTATION. PLATE 40

None of our first group, of naturalistic head sculptures, is entirely so, or even approaches the anatomical accuracy of classical Western statuary; each has some feature emphasised though hardly yet formalised: the high domed forehead of numbers 2 and 6, the thick lips of 1 and 2 and the broad nose of 3 and 5. It is a question which of the four men is the most natural: number 3, if not a close likeness of personal portraiture, undoubtedly bespeaks the calm dignity the Maori expected to see in a leader. His neighbour on this plate, number 4, is of like demeanour. It is only in number 4 of this group that tattooing is at all emphasized. We may notice emphasis in another direction, in number 6 the eyes made staring with shell inlay.

We could also differ as to the relative closeness to nature of the two female heads; except for the high stylized hair and comb the vote might go to number 2 whose delicate tattooing is a gentle enhancement. It is a pity we have to refer to these truly feminine creatures by number; they deserve names. Neither do we know where either of them lived. Each has been paid a compliment, Secunda by the Dominion Museum — she was their Christmas card in 1952, and Quinta by the nineteenth century cataloguer in the British Museum: on each card is a lightly outlined sketch for identification, but when he came to the little Maori girl he was constrained to spend no doubt an hour or more to leave there a completely and exquisitely modelled pen-and-ink drawing.

The male figures are from not far separated localities — Gisborne, East Cape, Opotiki. They do not provide a very clear opening for our discussion, later, on regional styles; but naturalism by intention is the absence of, or restraint from, stylization, which is what constitutes a style.

INTENSE EXPRESSION: PLATE 41

The heads shown on Plate 41 are still naturalistic but with heightened expression achieved by emphasis of one or more features. In each of them the carver has incised the tattooing more deeply to strengthen the overall pattern, while the eyes, made more prominent with shell inlay, now introduce a staring effect which we shall see as a wide-eyed glare in later carvings. In 5 and 6 the intensity of expression is further concentrated by the slant of the eyes combined with even stronger definition of the *moko* pattern. We can observe in 4 and 6 a strong curve of tattoo bands encircling the mouth, the latter made assertive with lip grooving in 6, and positively hostile with an armature of teeth in 3. The mouth, which in 3 is moderately open but evenly elliptical, as in speaking, in 6 is made mobile by the quite moderately dumb-bell form of the lips, the inception, more properly the introduction to us here, of the widely defiant mouth of other carvings, which in turn becomes a basic element in the strongly stylized face mask.

Already here in naturalistic renderings we see variation in proportion, heightening in 1 and widening moderately in 6. Unfortunately we have no locality record for any of these carvings.

MOKO: DECORATIVE ART. PLATES 42 TO 44.

The "featuring" of full *moko* in the naturally proportioned faces grouped for Plate 42, being accurate delineation albeit of ornament, is true realism. The faithfulness to the "fair copy", the tattooed face itself, may be gauged by comparing numbers 1 and 3 of Plate 43, the former a life cast made many years ago in this museum of the face of Wiremu te Manawa. Carvings portraying the tattooed face become part of Maori decorative art in so far as the natural model had been made decorative by a long and painful operation.

Number 3 of Plate 42, is of local interest; it is one of the identical pair of *amo*, front barge-board supports, of this museum's exceptionally large *pataka*, Puawai o te Arawa, the Flower of the Arawa, from Maketu, Bay of Plenty. Te Pokiha Taranui, a leading Arawa chieftain, built it in 1868. The embracing couple, symbolising the basic idea of the food-store, fruitfulness, is the most frequently seen motive for the *amo* of a *pataka*, but nowhere else, I think, do we find the male and female *moko* in better appearance than here.

By way of contrast Plate 42, number 4, from the Hunterian Museum, Glasgow, shows that a completely untattooed pair also can have a firmly expressive quality. The embracing pair design was sometimes set on the *kuwaha*, doorway panel, of a *pataka*.

The faces illustrated on Plate 44 add little beyond number and variety to the examples already discussed: number 1 enables us to mark the placidity of aspect ensuing when the full tattoo pattern is firmly asserted and number 4 the more stark realism when eyes and teeth are emphasised. They are all canoe prow ornaments, affixed basally at the front of the trapezoid type of *tauihu;* their common function by no means induced a sameness of expression.

ELASTIC PROPORTION: PLATE 45.

Two modest developments in style to be noted in the faces grouped on Plate 45 are a vertical lengthening in most and, in two, emphasis again of the *moko* by deeper carving. Number 1 is the head of a large *tiki* figure surmounting a *rahui,* a high post set up to warn against entry to an area temporarily made *tapu.* In 1846 the constantly steaming cliff behind the Te Rapa village at the southern end of Lake Taupo slid down to engulf the houses and their occupants including the paramount chief Te Heuheu Mananui. The area accordingly became *tapu* and was so observed for twelve months.

Numbers 2 and 3 are *tekoteko,* the latter of unknown provenance in the Bishop Museum, the former part of a finely carved small house gable from near Thames presented to the museum in 1877 by the chief Ngahuruhuru; the two lower faces of this group, 3 and 4, have the interest of showing to what high narrowness the Maori could extend a head and yet maintain acceptable naturalism. Expressive though simple modelling confers quiet dignity on 5, while raised ridge "tattooing" gives a rugged texture to 6; black paint asserts the tattoo pattern somewhat starkly in number 7.

The last, number 8, introduces a feature we shall see more markedly in Plate 50: modelling plus emphasized tattooing manifesting more of placid patterning than of the primarily intended dynamism. Design combined with naturalism, as we see it here, is the portent for the patterns and abstractions which are to follow.

NATURALISM BROADENED: PLATE 46.

It may be that to widen by much a naturally featured face is not easy; I cannot recall that it has been the successful practice of cartoonists however versatile. Nor apparently did the Maori carver find it easy; at least he left very few examples, none of them really wide.

Numbers 1 and 2 of Plate 46 are only a little beyond normal; one feels that the ample countenance of either could have found a semblance in the *ariki* or among the senior *rangatira* of a Maori community. Number 1, when eye-inlay had been affixed, might even have looked aggressive, but the narrow eyes and moderately parted lips of number 2 present us with a more reserved though alert demeanour.

Number 3 is the broadest naturalistic face we can find. Pukaki, a notable Arawa chieftain of the eighteenth century, stands in this museum, an altogether massive statue for which the exceptionally wide head is quite appropriate. He, too, is of grave aspect with by no means vigorous but quietly ornamental *moko*, and you may notice a neat sculptural device — the normal eye area made smooth leaving it to the deep brow shadow to provide a substitute impression, effective in our Maori Court, and even more so in the open sunlight where Pukaki originally stood. We have no locality record for number 2; the others stood beside Lake Rotorua, Pukaki at Te Ngai.

DEFIANCE BECOMES DECORATION: PLATE 47.

The not infrequent Pakeha response to Maori sculpture or woodcarving is the comment: "distorted; grotesque", and I suppose there's no denying it; yet one can confidently rebuke the denigratory overtone of the words and uphold the Maori craftsman's truly artistic purpose, and achievement. That purpose, in the examples presented in Plate 47 was primarily the vigorous expression of feeling, the portrayal of a mood of energetic defiance, as is clearly manifest in 1 and 2.

While this was the sculptor's prior intention, the very method and form he used to express it introduced another concept with some conflict in art motive. "Distortion" is but the emphasis of features, achieved here by rendering forehead and lips in broad raised bands and enlarging the eye-sockets, whereby besides outlining features they also became areas inviting decoration.

This does not diminish defiance in the first two, and does so only slightly in number 3; but in the others ornament becomes so broadly applied that it asserts itself above portrayal of expression; moreover, in overall presentation, in the form and ordering of bands and curves, a further element, the quality of proportion, makes its appearance, also that of balance and of symmetry, so that with their further development an aesthetic motive — design — in large measure supersedes the portrayal of defiance as primarily delineated.

So it may seem to us, to the Pakeha unaware of the meaning which gave origin to these design forms. Could it have been otherwise with the

eighteenth century Maori community, or with its wood carvers? The question occurring to one here is whether, after having attained these decorative art forms, the carver remained in full awareness of the underlying meanings and continued to believe that his forms expressed the primarily intended feelings; or had he, now concentrating on the design, forgotten the symbol? Moreover, were the Maori beholders who accepted and responded to the decorative aesthetic, still aware of and affected by the meaning originally inherent in what was before them?

The question, having to do with conditions of two hundred years ago, perhaps remains unanswerable, unless light should be thrown on it through study of some other native art still being practised in an unmodified tribal community. A question nearer home could be: to what extent are our present day Maori carvers presenting symbols with meaning, or creating art forms only for art's sake?

MASKS IN SQUARE OUTLINE: PLATE 48.

Naturalism, by definition, implies restraint or limitation, and this in bodily proportion as well as features; but not altogether, for the naturally featured head could, as we have seen, be lengthened vertically (Plate 45), although horizontal extension was not so readily attempted. Stylization, although its first step may be simplification, offers better opportunity and invitation to exploit and develop form itself, as the Maori soon discovered, and it was the defiant mask convention that enabled him to "distort" the face acceptably, to extend it upwards or to draw it out sideways as he himself wished, or as the proportions of his given area required.

When the stylized face had been turned to profile, even better scope offered for ingenious distortions and for designs leading to patterns of lively elegance: a later paper, on the *manaia,* will consider these in some detail.

The group we now approach, Plate 48, show the near-square as still close enough to normal face proportions to make naturalism or stylization equally appropriate. We see in number 1 a face in the simplest naturalism with only the slight woman's tattoo pattern to disturb the almost Buddha-like serenity — there were a few female Boddhisatva, were there not?

In number 2 we see again the fully tattooed male face: it surmounted a palisade gateway, and its perforated eyes and mouth were intended to give, from afar, assurance of a watchful reception, with announcement of welcome or hostility according to whether you were approaching as friend or foe.

Examination of numbers 3 and 4 reveals that in a free-standing image the carver could allow himself a degree of freedom for outline detail, and in association with it to introduce (number 4) a pierced design.

Ornamental detail is sparingly applied in these semi-naturalistic masks, nor has it, in number 5, yet become as elaborate as we see it elsewhere. I had thought to nominate number 5 as a "typical" stylized mask, but nothing can be regarded as typical of so wide a range where every stage or variety of simplicity or complexity is to be seen.

Locality is recorded for only one of this group, number 2 from the Okarewa Pa, Whirinaki River, south-eastern Rotorua district.

COVERING WIDE BOARDS: PLATE 49.

Among the many occasions for carving a full-face mask, and I give illustrations of but a quarter of those which I have, there appear to have been rather fewer widely outdrawn than for tall and narrow designs, how widely and how effectively these few photographs will show. Here we have a nearly square *koruru* (number 2), the verandah gable ornament of a carved house; numbers 3 and 5 are the end and the longer side of a large *waka huia,* a box for valued feathers. The not very large house at Manutuke, nine miles inland from Gisborne, has the unusual feature of a 8 or 9 inch high base to the wall-carvings. These bases extend right across the *poupou* for the figure to stand upon, and are necessarily very wide (number 6). Fig. 4, of intermediate width, is also an interior house unit; at least it is stated in Hamilton's Maori Art (p. 130) to be one of the skirting boards (*epa*) between the *poupou,* of the Turanga house in the Dominion Museum, but I have not been able to identify it there. It does have considerable resemblance in details to the faces of the *amo* of this house, also to the centre carving within the doorway. There are, moreover, similarities between number 4 and number 2, both in general design, except eye-sockets and eyebrows, also in the teeth and in the spirals and loops of the broad lips and forehead, and in the lug-and-peg fastener (dummies in both cases I suspect) on the cheeks. The Turanga house locality is Manutuke, that of number 2 also is Poverty Bay.

These carvings exemplify the essential plasticity of the stylized mask design; no doubt it could be widened even further than number 6, but I doubt if it ever would have, because the Maori had a ready sense of proportion and of the acceptable limits of such extension; moreover his repertoire included too many alternatives, i.e. of the profile *manaia* and of whole-figure conventions, to allow him to fall into awkward design situations.

INCREASING HEIGHT: PLATES 50 TO 53.

In the next plate (50) we group a quartet of stylized faces varying slightly from natural to somewhat heightened proportion, and follow in the same plate with another four again slightly higher and narrower. This trend continues gradually in the succeeding illustrations, but it is gradual only as I have chosen to arrange the twenty-five photographs in these four plates. The word "trend" should not be taken as implying a steady and progressive increase in height or narrowness by a given school of practising *tohunga.* The gentlest winds of change have constantly drifted in all directions over Maori art, which found its expression either in the occasion's practical requirements of size and shape or in the individual artist's feeling for form or design, either or both. If we will but look we shall see in every piece an example of creative design, meet for the occasion.

As well as in observing the changes in proportion themselves, there is no little interest in noting the details and devices that served the carver's purpose — for example his method of drawing up to extreme height. The stylized mouth, he apparently thought, should remain wide across; to over-open it upwards would be unacceptable. Instead, taking a hint from the oblique eye-socket, he found opportunity, and satisfaction no doubt, in lifting upward the whole of the upper face: nostrils, cheek-bones, eyes and forehead (Plate 52).

It would be tedious for me to describe details: better that you yourself should examine at leisure the last five illustrations of this group (Plates 52 and 53), and perceive the aptness with which the *tohunga whakairo* could

cover and adorn an area with bands and curves and blank spaces. The essential features of a human face are here arranged and combined in a design for which the term "decorative art", or either word by itself, is appropriate and just.

REGIONAL STYLES

In approaching the question of regional art styles or style areas, we should give prior attention to the factors comprising the problem and the criteria for our comparisons and judgments; some are inherent in the definition of art style area and, with others, could be:

a style should stand apart, different and readily distinguishable from other styles;

most, or a considerable proportion, of the known examples of a style should be from the one region, and the style should be prominent, if not dominant, in that region;

examples of the style not actually within the area should occur near rather than distant from it; in other words diffusion from the area should be steadily diminishing, though separated localities in frequent intercourse might share a style or its elements;

a style should not be more strongly correlated with a particular object or type of object than with an area;

art areas should be based on pre-European pieces of definite provenance.

Such precise conditions could prevail only where a community had remained undisturbed and unmodified by intrusive elements; European occupation in New Zealand, bringing increased opportunities and incentives for movement and intercommunication, soon began to obscure boundaries of all kinds. Although in the early years of contact not a few good stone-carved art objects were acquired by Europeans to be taken or sent home, they were nearly all small, easily carried articles; moreover, locality records were seldom made, or, if they were, have almost invariably been lost. Large carvings, as of houses or canoes, through size or through being part of a structure and in a way communally owned, would hardly have been obtainable, and by the time administrators were in a position to acquire carvings, as Sir George Grey did for the British Museum, steel work only was available, and here again localities were hardly ever recorded. Reliably localized Maori objects are rare in northern hemisphere museums. Our own museums, also, contain many unlocalized specimens acquired, not from the original owners or collectors but from their descendants or relatives.

The few reliably localized early pieces in New Zealand museums have been considerably augmented over the years by swamp-recovered specimens. I was surprised on checking to find that in my forty years here swamp-recovered acquisitions have been almost one each year; Taranaki Museum recoveries have been equally gratifying. It is such specimens that will best help to elucidate pre-European art areas.

Museums also have many steel-carved pieces of confirmed provenance as well as those uncertain or unknown. A century or more of building carved houses, and in the earlier years of canoe construction, sometimes with the individual carvers known as well as the tribe, has produced a considerable body of carving consistent in style, sufficient to indicate that a tribal or area tradition was being followed. This is good in its way, but the light these throw on the pre-Pakeha art of the area must by its nature be uncertain, and the uncertainty is increased by there being, in this area of last century house building (Bay of Plenty, East Coast, Hawkes Bay, Wellington), very little other than 19th century carving available for our study. Excluding a few naturalistic sculptured figures, which because they are natural are much alike, only six swamp-recovered pieces or house sets (a *pataka* doorway, Thornton, Dominion Museum; a *pare,* Te Puke, a *taurapa* Tauranga, a *poupou* from near Opotiki, the Te Kaha *pataka* carvings, and a *poupou,* Whangara, all in this museum) are known to me.

One could include a number of uncertainly localized early pieces in, say, East Coast or Bay of Plenty style, but this would be to judge the horse from the cart; style areas cannot be established through carvings localized on the basis of style. Such may legitimately be cited as following a certain style, but not to define its area.

However, we should not expect to find in art, a cultural phenomenon, a clear-cut order of style areas comparable to the distribution areas of plants or animals, for which the basis of classification is the single line of physical heredity. Even though art forms may be in such close rapport with the customs and requirements of a community as to be identifiable with it, art develops through the moods of individuals and out of their responses to what they see and hear wherever it may come from.

The study material for style areas therefore comprises: firstly the by no means numerous pieces of pre-European origin, and secondly the very considerable number of nineteenth century steel-carved examples. Each group as it happens becomes separately the major evidence in respect to one or the other of the two major North Island art-style regions that can be recognised: for the Northern-Western third of the island where carving appears to have been very little continued after European contact we have most of the pre-European swamp-recovered pieces, while for the much greater East-Central-Southern region where few swamp-recoveries have been made we have the abundance of early nineteenth century work.

We continue with drawings and descriptions of faces and masks from each area, noting the differences between them, also the likenesses and such inter-relationships as they may suggest. The latter are by no means non-existent between the three well-differentiated style-areas, Northern, Hauraki, Taranaki, which comprise the Northern-Western region, which we will consider first.

Masks and faces are of course not the whole of the evidence; this should include body and limb forms and decorative detail together with the summation of all these in overall composition. The examples illustrated, except one, have the virtue of precise locality record for both stone and steel work; the latter we think are of sufficiently early nineteenth century date for us to regard them, not certainly but with a fair measure of confidence, as pointing to the classical pre-Pakeha style of their respective areas.

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Fig. 1a 1b 1c

The Kaitaia carving (Fig. 1a) stands *sui generis* in Maori wood-sculpture, yet not altogether, for its lintel form and composition are but an outward extended *pare* design. It is its central figure that sends us to look around for possible Oceanic relationship, and further afield to Borneo where Skinner (1924:237, Pl. 9) shows it in comparison with a roof-ridge feature. He, and McEwen (1966:417) both regard it as akin also to the Society Islands two-man carving described by Emory (1931:253-4), and, thereby, as pointing towards an early rectilinear art postulated for New Zealand and Polynesia. McEwen also regards the central figure as reminiscent of Austral Island work.

Our figure 1*a-c*, shows that, except for the triangular outline of the Kaitaia and Society Islands faces, the three are very unlike in feature portrayal i.e. eyes, nose, and mouth; other Society Islands faces also differ in every way from Kaitaia. Further unlikeness appears in body form: the Kaitaia head slopes forward over an indrawn dwarf body, in marked contrast to the erect, forward-protruding, naturally proportioned bodies of Austral and most Society Islands images, while the body-stylization of the two-man carving is quite of its own kind, indeed unique within its own group.

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Fig. 2a 2b 2c 2d

Triangular faces are uncommon but not rare in Maori carving appearing usually in mask designs (Fig. 12*a*). The Kaitaia figure stands aloof even from its immediate Northland neighbours whose elongated heads become narrower above (Figs. 2 and 3) not below. The exception, and exceptions are the rule with our versatile Maori carvers, is the face of the Three Kings slab described by the writer in 1948 (p.207); this is undoubtedly northern in decoration (Fig. 6*b*) but is a formalized mask, not a naturalistic rendering. Its closer affinity would be with Taranaki faces (Figs. 7 and 8).

The northern style is sufficiently attested in a number of old bone-chests (Fig. 2) mainly Hokianga-Whangaroa in provenance but known

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Fig 3a 3b 3c 3d

also from Raglan (Dominion Museum, Fig 2*d*) and, a single ploughed up imperfect specimen, from Tauranga (Auckland Museum). The style is further exemplified in *poupou* (Takahue, Fig. 3*c* and Kaipara, Fig. 3*a* and *b*) and in some *waka huia*, though of the latter only one is of definite provenance.

The style characteristics are the up-lengthened head narrowing above the eyes; features outlined by narrow decorative bands in shallow relief; the tongue when present expanded distally and protruding sideways; the body smooth, undulating, with the surface-ornamented limbs elegantly disposed in countervailing curves.

Several articles have been attributed, on style, to Northland, resulting at times in some confusion. The exceptionally fine trapezoid canoe-prow in the British Museum is undoubtedly northern in style and details and, apparently on this basis, has given rise to the belief that the trapezoid prow itself is the "northern type". But the British Museum prow, the only one with northern style figures and surface detail, is unlocalized. A firm northern provenance for the trapezoid prow is Bream Bay (D'Urville's plates 49 and 60); a doubtful one in our museum, was "captured at Great Barrier by Ngati Whatua from Kahungunu", who had obtained it, where? Other records are Auckland (Hamilton, Maori Art pl V, on the basis of photographs obtained at Auckland (!), though one was repeated by the Princes Street dealer E. Craig when he sold it to Canterbury Museum); and Waikato River (Auckland Museum). A small pre-European prow from Mokau (Archey 1956:373) is trapezoid in outline but with an internal design that is the simplest version of the double-spiral composition of the fully ornamented *tauihu* of the *waka taua*, the great war canoe of coast-wide distribution. The known localities of the tropezoid prow and the different art renderings it displays show that it was not of restricted distribution.

The *poupou* whose head is our Fig. 3*d* is in like case, often cited as northern which its patent similarity to *a b* and *c* makes very likely; its provenance is "near Auckland", but we do not know whether from to the north, south, east or west, or how near is 'near'.

The refined economy in design of *c* deserves more than a glance; in this respect all these four stand in marked contrast to the intricately involved patterns of several northern type, but still unlocalized, *waka huia*. One of these warrants comment: presented to Peabody Museum, Salem, by Captain W. Richardson in 1807 (Dodge, 1941: 20; Plate I,42) it is

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Fig. 4a 4b 4c

obviously steel-carved, and is in match-white unhandled condition. One can only guess a Whangarei to Whangaroa locality for this splendid carving, and only guess again that the chisel or knife had been Richardson's gift to the carver.

We are without information as to the possible extension of the Northern style south of the Waitemata. "Near Auckland", just mentioned, cannot be taken into account, moreover the reason for our ignorance, the overwhelming of the Tamaki tribes in the 1820's by the Kaipara Ngati Whatua, is itself two-way evidence: either it destroyed whatever of art that may have been here, or it indicates an intertribal hostility and opposition that could have prevented a sharing of art style. Nor did the style appear to have been canoe-borne *via* the Firth of Thames, for it was along this shore that the clearly different, though related, Hauraki style is well documented by swamp recoveries. The central face of the Patatonga *pare*, one of the finest examples of Maori art, is outlined in Fig. 4*b*, flanked by two other faces from a close nearby recovery. The sub-rectangular outline is in a way the northern style kept to more natural head proportions; the Hauraki style shares with Northern, and also with Taranaki, faces bare of detail ornament except for the lightly bar-crossed narrow bands which outline eye-brows and lips. The three styles have also in common smooth un-ornamented bodies, with the legs alone decorated—in pleasant shallow pattern.

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Fig. 5a 5b 5c

The greater width of the faces of Fig. 5 is in a way a crowded down height imposed by the limited area of the small all-over patterned *pare* of which they are the central features. Fig. 6*c*, although recovered it is said from seven feet below ground on the shore of the Firth of Thames, seems likely to be an intrusion — all four carvings of the *pataka* set of which it is one are in typical East Coast style (cf. Fig. 16).

Fig. 6a 6b 6c

While the sharing of basic features by Northland-Hauraki-Taranaki affirms a measure of unity for the whole northern-western North Island region, the separate individuality of Taranaki is patently asserted by the flexure and sinuosity of entwined bodies and limbs and by the ample curves and loops (Figs. 7 and 8) which give the Taranaki face its

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Fig. 7a 7b 7c

immediately recognisable appearance. Especially typical are two median prominences: a pointed cone, high usually but not invariably, above the forehead, and a sharp-pointed chin; chins here however may be evenly rounded. A narrow tongue curves sideways over the lower lip.

Fig. 8a 8b 8c

The untypical (in its even roundness) form of the Manukorihi *pa* face (Fig. 9*c*) is also the outcome of a compositional hazard: it is the central feature of an unusually low or narrow *pare*. It has likenesses to the small *poupou* mask from Tangarakau (Fig 9*a*), which also has other likenesses

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Fig. 9a 9b 9c

to Taranaki. On conjecturing whether these are of significance for area relationship or only coincidental, one recalls that Waitara was a prolific centre rich in individual variation in both form and detail; Tangarakau is only 44 miles directly inland from it, but over difficult hills not even yet roaded, and its better communication would have been by river south to Wanganui. This Tangarakau piece is the only undoubtedly old house carving from a Wanganui source; an early (1824) nineteenth century post from 57 miles up-river (Te Aomarama) commemorating the birth of Major Kemp (Phillipps 1955:108) and recovered by T. W. Downes from an abandoned and delapidated *pa* site, shows the faces of Kemp's parents with lips (Fig. 10*a*) much expanded as a low evenly-curved dome covering more than half the face and enclosing a relatively small mouth. This feature, so different from the narrow-lipped wide open mouth of the much further up-river Tangarakau carving, appears, though not quite so large, at Koriniti and around Wanganui, also in Manawatu and Wellington.

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Fig. 10a 10b 10c 10d

In other feature detail than expanded lips, Wanganui to Wellington carving follows the eastern North Island style, while Tangarakau's affinity seems to be more westward to Taranaki than down river.

I do not include Barrow's (1959, 1961) Wanganui style, i.e. of godsticks, as an area style, notwithstanding its being borne by a number of godsticks from thereabouts. As an art style it is by no means restricted to the Wanganui district, either for godsticks or for other objects. It is seen in practically all *toki pou tangata*, in heads on feeding funnels, on *putorino* and on the larger faces of the curious but always finely carved slotted objects whose identification and use still evade us; all of these are of New Zealand-wide occurrence. "Provenance" assigned on the basis of the "Wanganui style" is, I submit, invalid for uncertainty.

Entitlement to regional status could perhaps better be accorded the stick-gods uncovered by a receding lake level near Waverley and described by T. W. Downes (1932), and some also from near Wanganui. But being undoubtedly very early and also near-naturalistic, they do not comprise one of the pattern types we are discussing of classical Maori art styles; nor do they suggest a basis of origin for any one of them.

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Fig. 11a 11b 11c 11d 11e

The non-scale drawings of Fig. 11, with that of an unusually long-faced canoe ornament from upper Wanganui river, are included here for record.

There are examples a-plenty of wood-sculpture from the second major art region, i.e. the remainder of the North Island — from Bay of Plenty through the centre and the east coast to Wellington. So much of good quality stands in fine carved houses or is preserved in museums as to suggest, nay, to affirm, that carving neither faltered here nor slackened in vigour because of European occupation. It would seem that wherever there was material or economic well being, the carving of commemorative statues, the building of *whare whakairo,* the production of canoe prows and sternposts and of smaller art objects such as treasure boxes and musical instruments, was actively continued.

Altogether this output would seem to indicate a half-century of burgeoning of Maori art inspired perhaps equally by prosperity and by new steel tools. We do not here suggest, as if following Groube 1964, that the richly carved *whare runanga* first appeared in early Pakeha times: large stone-tool house carvings in museums (the Helensville planks, Patetonga *pare,* and Te Kaha *pataka* in Auckland) stand against this view. Building status was, however, certainly sought in mid-nineteenth century. To cite Auckland examples again: although Pokiha Taranui (Major Fox) could scarcely, in decency, outbuild Rangitihi, *whare whakairo* of his elder brother Waata Taranui, he could, and did, build an outsize *pataka,* Te Puawai o te Arawa. Yet the stone-carved Patetonga *pare* outmatches in size Rangitihi's *pare,* and also that of the still larger house Hotunui. Had Major Fox known, in 1868, of the existence and size of the Te Kaha *pataka,* Te Puawai could conceivably have been even larger.

What to the early nineteenth century Maori was no doubt but a continuing of usual art activity, could well seem to us Pakeha today almost as a renaissance, but, again for us, a renaissance for which we now seek uncertainly for the classical prototypes. In the outcome there is now before us a medley of trends and styles throughout the whole region, and to unravel it would seem almost to call for T. S. Eliot's "Time yet for a hundred indecisions, and for a hundred visions and revisions".

Fig. 12a 12b 12c

The principal evidence for these area styles, better than canoes which travel*, will be the carvings of the few still standing houses of the first half of the century, with the reservation that the evidence for a district may be a single house, the work and the style of only one *tohunga whakairo* or his immediate family group. Nevertheless McEwen (1966: 419-426) has shown that beyond quite local styles some wider areas are to be recognised, though his outline of, for example, the Kahungunu east-coast style is, as he says, a description of the notable carving of Te Hau ki Turanga, now in the Dominion Museum. Had the nearby and not much later house, Turanganui a Kiwa, been the model, important features such as feet, hands, and tongue would have proved different. Moreover, details of both these Manutuke houses are seen elsewhere, even as far away as Rotorua (head form, both outline and detail), and a characteristic detail such as the spiral on eye-pupil even in Northland, on Kawau Island and near Pipiriki. But it is a combination of characters that defines a style, though even this eludes us in this enterprising and diversified region. While therefore we now present drawings of localised carvings of the Central-Eastern region we are well aware that the features noted are not precise area characteristics, but reflect, rather, nineteenth century intercommunication of people and interchange of ideas.

Fig. 13a 13b 13c

An Arawa style is readily recognisable (Figs. 12 and 13): the sides of faces are usually gently incurved to a slightly less than full-width mouth. The diagonal eye-socket with low-arched eyebrows, the *wheku* type

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* Te Toki a Tapiri, built in the eighteen forties on the East Coast, was brought to Auckland as an inter-tribal gift.

(McEwen 1966:421), is commonest for the *poupou* of houses; on broader slabs in *pataka*, or on broad superimposed figures, round arched eyebrows with circular eyes *(koruru* type) are as common as the *wheku*. Almost invariably there are round, or oval cheek-bone bosses.

The recognition by Maori house carvers or designers of the architectural forte of some uniformity of style in a series is evident throughout the East-Central-South region, and nowhere less than in Rotorua. All the *poupou* faces of our house Rangitihi — fine carvings be it said and rivalling Mr McEwen's choice, Te Hau ki Turanga — are of the high sloping diagonal type (Plate 52, Fig. 1); a Ngatai Porou house, Porourangi, impressed me many years ago not so much by the standard of any one *poupou* but by its unity in carving design — an architectural *ensemble*.

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Fig. 14a 14b 14c

In Rangitihi faces, the elongated eye-socket and its brow ridges stay close together, whether sloping high or low; in other Arawa faces of our drawings (Figs. 12*c*, 13*a*) the eye-lines remain low but the brow-ridges are lifted away from them right to the vertex, where they become of necessity quite narrow bands. By this means the carver, always seeking variety, achieves a high smooth area between eyes and eyebrows.

Fig. 14*a* is another wide, low face compressed into a restricted design space; its eyes are but wide low swellings. Our figures 14*b* and *c* are from mid-Bay of Plenty and from Te Kaha; they resemble each other although separated by the Matatua-Hotunui house centre (Whakatane district) of distinct Ngati Porou affinity. Both are of pre-European age, which with their likeness to one another, might be thought significant for possible earlier art-area connections.

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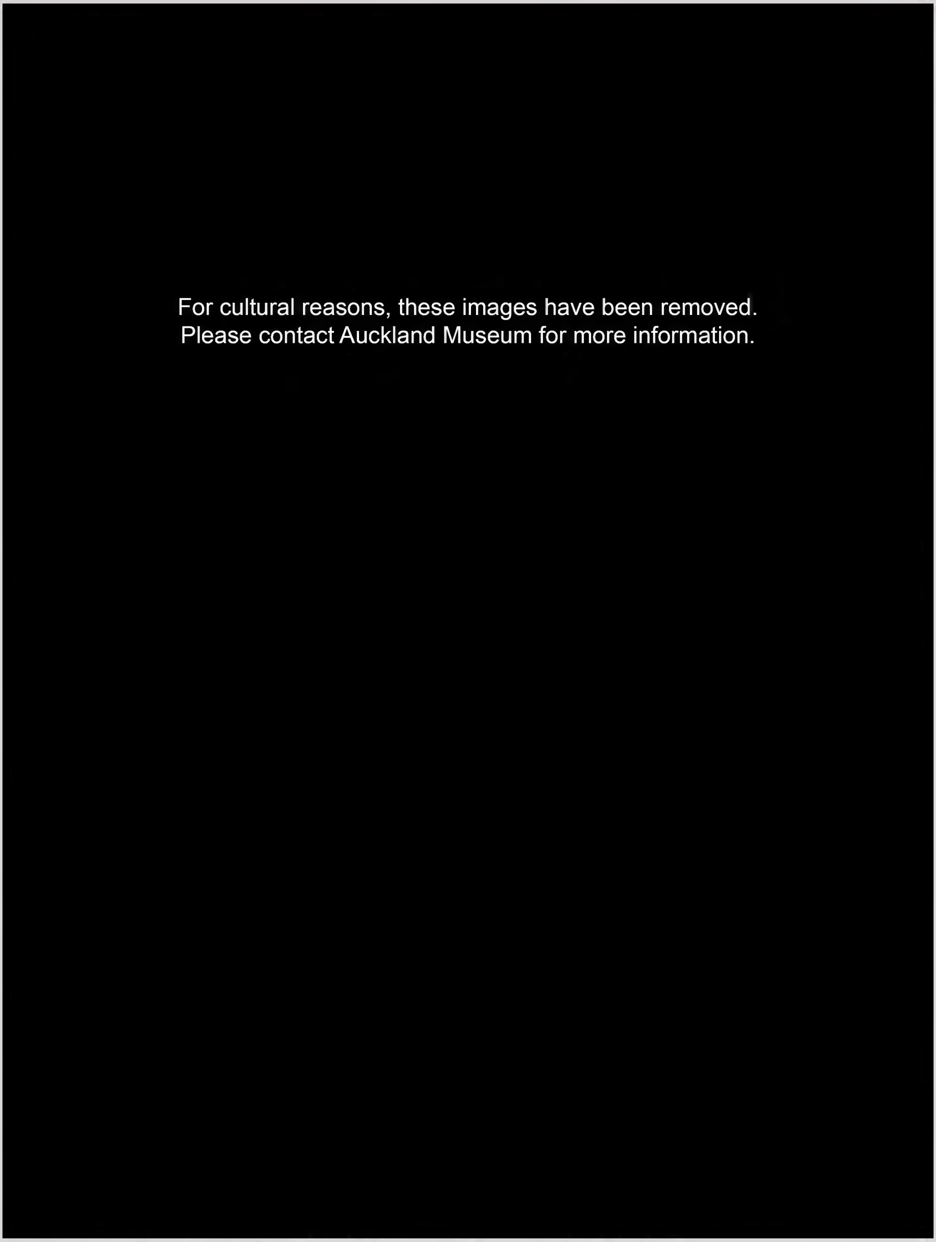
Fig. 15a 15b 15c

PLATE 39



Tattooed Maori Head. Natural History Museum, La Rochelle.

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1. Kaiti, *tekoteko*, whereabouts unknown. Dominion Museum neg. 7312.
2. Locality unknown. Dominion Museum 10955.
3. Opotiki district. Auckland Museum 5167.
4. East Cape district. Auckland Museum 163.

the local manner were content to follow it, no art could have achieved much through their unambitious routine; no art could attain to such wide divergences in style and variety within every style without discernment, imagination and enterprise.

What was an almost unfailing quality in Maori art was felicity in design, and this argues the existence among its exponents of sensitivity and an alertness to design potential in whatever task was in hand. The leader of a group of carvers, the *tohunga whakairo,* would, besides being himself sensitive and inventive, have observed that neighbouring as well as distant fields were green, and, while having a natural preference for and loyalty to his own school, he would see possibilities elsewhere and respond to them, whereby boundaries would from time to time be crossed.

In early European days exchange of carvers was not unknown. Mr McEwen has drawn my attention to Cruise (1823:27) who, when visiting the chief Wetere on the banks of the Waikare river in the Bay of Islands in 1820, was told that the carver then working on a new *pataka* had been brought from Thames (a distance of over one hundred miles from Waikare), for that purpose.

There would have been little interchange in the early years of Maori settlement of this country, when communities were fewer and further apart, and these were the conditions conducive to local style development.

A wider question that ensues, a possible overall distribution pattern of style areas seen in relation to tribal canoe areas, leads us back to the more fundamental problem of the origin(s) or the derivative source(s) of Maori art itself.

These questions may be out of place in a paper on masks and faces which as we indicated earlier, form but part of the whole evidence, and which in any case do not appear to have revealed such marked differences as are evident in body form. A preliminary statement of the factors involved, even some tentative conclusions, could, however, invite comment and bring forward other aspects of the problem, whereby a fuller investigation could more profitably be undertaken.

We have seen that stylized faces, masks, as I call them, do stand in two major regional styles; these regions differ even more markedly in the active stance of figures themselves in the Northland to Taranaki region, in their rhythmic undulation and sometimes intertwining, in contrast to the usual upright, steady pose of major figures in the Bay of Plenty to Wellington region. Is it then at all significant that these two art-style regions can also be seen as two separate groups of tribal canoe-ancestry areas? These, as given in Sir Peter Buck's "Coming of the Maori" (Hiroa, 1949:337) are:-

CANOES	TRIBES	DISTRICTS
Tainui	Waikato tribes, Ngati Haua, Ngati Maniapoto, Ngati Maru, Ngati Paoa, Ngati Raukawa, Ngatitoa, Ngaitai (Bay of Plenty)	Waikato, King Country, Hauraki, Coromandel, Cambridge, Kawhia
Tokomaru	Ngati Tama, Ngati Mutunga, Ngati Rahiri, Manukorihi, Puketapu, Atiawa, Ngati Maru	North and Central Taranaki

Kurahaupo	Taranaki, Atihau (Whanganui), Ngatiapa, Rangitane, Muaupoko, Te Aupori, Te Rarawa	Taranaki, Wanganui Manawatu, Rangitikei, Horowhenua, North Auckland
Aotea	Ngati Ruanui, Ngarauru, Atihau	South Taranaki, Wanganui
Mamari	Ngapuhi, Rarawa, Aupouri	North Auckland
Mahuhu	Ngati Whatua	Kaipara, Auckland
Te Arawa	Ngati Pikiao, Ngati Rangitihi, Ngati Rangiwewehi, Ngati Whakaue, Tuhourangi, Ngati Tuwharetoa	Rotorua, Taupo
Matatua	Ngatiawa, Tuhoe, Whakatohea, Whanau a Apanui	Whakatane, Urewera, Bay of Plenty
Takitimu	Rongowhakaata, Ngati Kahungunu, Ngaitahu	Poverty Bay, Hawkes Bay, Wairarapa, South Island
Horouta	Ngati Porou	East Coast of North Island

Assuming one common origin for all Maori wood-sculpture, we might see conditions for regional art differentiation either within the field of physical geography, or, if we knew tribal histories in sufficient detail and for a long enough period, in separation arising from their socio-political history.

The alternative is separate overseas (Oceanic) origin for these two art-or-canoe regions. Our present knowledge of Polynesian art forms points not to art form but only to content, the human figure, as an element in common. On the other hand we see in Maori art itself, despite variations, every appearance of the art styles of this country having all developed through the same motive and manner, stylizations of the human figure, stylizations which also share too much of manner and detail as to argue separate origins for them.

SOURCE RECORD FOR TEXT-FIGURES (1-18)

Initials (AM etc.) indicate the present locale of specimens.

AM Auckland Museum.
BM British Museum.
CM Canterbury Museum.
DM Dominion Museum.
NE No longer existing.
NMI National Museum of Ireland.
PC Private Collection.
PR Pitt Rivers Museum, Oxford.
TM Taranaki Museum.
WM Wanganui Museum.

Fig. 1
Maori and Central Polynesia
a Kaitaia Carving. AM 6341
b Raivavae: stone. PR
c Society Islands. BM

Fig. 2
Burial Chests: Northern
a Waimamaku. AM 5654
b Bay of Islands. AM 6404
c Waimamaku. AM 5660
d Raglan, south of. DM

Fig. 3
Faces on *poupou*, Northern
a Kaipara. AM 6206
b Kaipara. AM 6394
c Takahue. AM 37399
d "Near Auckland." WM 51.751

Fig. 4
Faces on Hauraki *pare*
a, b, c Patetonga. AM 6189

Fig. 5
Hauraki District: faces on *pare*
a Thornton's Bay. AM 18681
b Patetonga. AM 6307
c Oruarangi. AM-(dep.). 33309

Fig. 6
a Te Awamutu. PC
b Three Kings Islands. AM 30411
c Miranda, Firth of Thames. PC

Fig. 7
Faces on *pare,* Taranaki
a Waitara. TM
b Te Kawau, north of Awakino. AM 6087
c Waitara. AM 33737

Fig. 8
a Waitara. CM
b Waitara. DM neg. 263
c Waitara. TM

Fig. 9
a Tangarakau. WM
b Tangarakau? WM
c Waitara. DM 5249

Fig. 10
a Te Ao-marama, Upper Wanganui R. WM
b Lower Hutt. DM 3775
c Wellington District. AM 18426
d Manakau: house Kotahitangata, NE. Koruru, PC, Phillipps 1955, 36.

Fig. 11
a Waverley. WM
b Waverley. WM
c Wanganui. WM
d Waverley. WM
e Upper Wanganui R. WM

Fig. 12
a Rotorua. AM 202
b Maketu. AM 5168
c Rotorua. AM 184

Fig. 13
a Rotorua. AM 5152
b Rotorua. AM 5152
c Taupo. AM 4710

Fig. 14
a Te Puke. AM 2024
b Thornton, Bay of Plenty. DM
c Te Kaha. AM

Fig. 15
a Manutuke, Turanga house. DM
b Poverty Bay. NMI
c Manutuke, Kohupo tribe former house. NE

Fig. 16
a Manutuke, Turanga house. DM
b ,, ,, ,, ,,
c ,, ,, ,, ,,

Fig. 17
a Hawkes Bay district. NE. DM neg. 376
b Whangara. AM 5017
c Te Hauke, Hawkes Bay. NE

Fig. 18
a East Cape. AM 702
b Whakatane, Ngati Maru house, Hotunui. AM

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Tattooed Maori Head. Natural History Museum, La Rochelle.

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1. Kaiti, *tekoteko*, whereabouts unknown. Dominion Museum neg. 7312.
2. Locality unknown. Dominion Museum 10955.
3. Opotiki district. Auckland Museum 5167.
4. East Cape district. Auckland Museum 163.

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5. Locality unknown. British Museum.
6. Opotiki. Auckland Museum 5167.

PLATE 41

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1. Locality unknown. Dominion Museum 246.
2. Locality unknown. Royal Scottish Museum.
3. Locality unknown. University Museum, Philadelphia, 52-35-1.

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4. Locality unknown. University Museum, Philadelphia, 3107.
5. Locality unknown. National Museum of Ireland.
6. Locality unknown. National Museum of Ireland.

PLATE 42

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1. Locality unknown. Private French collection: photos, courtesy Galeria Jaques Kerchache.

2. Locality unknown. Private French collection: photos courtesy Galerie Jaques Kerchache.

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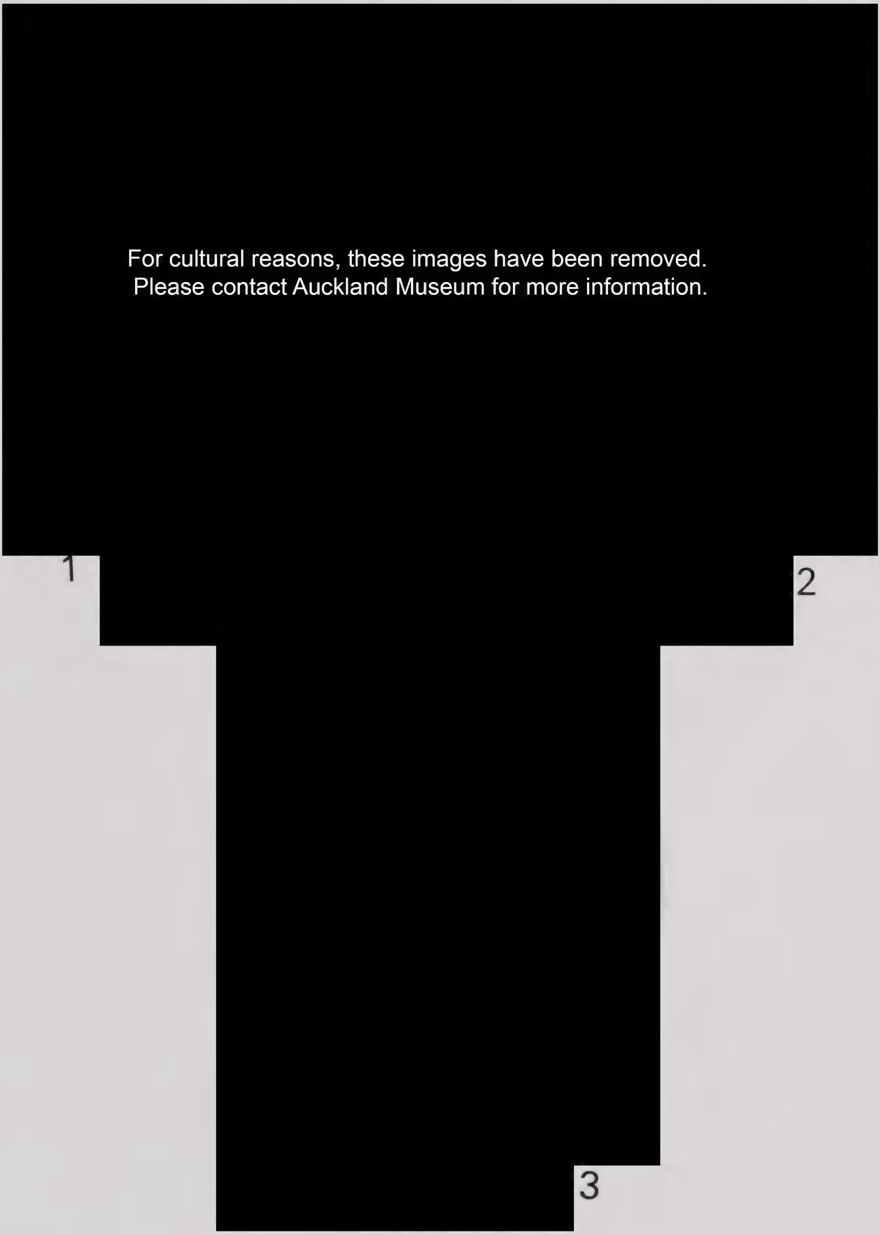
3. Maketu. Auckland Museum 151.

4. Locality unknown. Hunterian Museum, University of Glasgow E332*b*.



1. Cast of face Wiremu te Manawa. Auckland Museum.
2. Rotorua: the house of Rangitihi. Auckland Museum 5152.
3. Locality unknown. Dominion Museum neg. 150 B.

PLATE 44

For cultural reasons, these images have been removed.
Please contact Auckland Museum for more information.

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2

1. Thames district. Auckland Museum 5998.
2. Auckland (Hamilton, Maori Art: 16). Otago Museum.

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4

3. Locality unknown. Auckland Museum 2711.
4. Locality unknown. Pitt Rivers Museum, Oxford 3313.

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1. Lake Taupo. Auckland Museum 22051.
2. Thames. Auckland Museum 173, but Maori donor was Ngati Whakaue, Rotorua.
3. Locality unknown. Bernice P. Bishop Museum.
4. Locality unknown. Dominion Museum.

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5. East Coast. Dominion Museum.
6. Bay of Islands. Auckland Museum 4317.
7. Locality unknown. Dominion Museum 3910.
8. Whetu Gorge, Bay of Plenty. Otago Museum.

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1. Rotorua. Auckland Museum 172.
2. Locality unknown. British Museum.
3. Lake Rotorua. Auckland Museum 161.

PLATE 47

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1. Tolaga Bay. Auckland Museum 179.
2. East Cape district. Auckland Museum 154.

For cultural reasons, these images have been removed.
Please contact Auckland Museum for more information.

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3. Wairoa, H.B. Auckland Museum 20103.
4. Locality unknown. Auckland Museum 22066.
5. Locality unknown. British Museum.
6. Locality Unknown. Auckland Museum 6335.

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1. Locality unknown. Dominion Museum. 8516.
2. Whirinaki river. *Okarewa pa.* Otago Museum.

3

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For cultural reasons, these images have been removed.
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3. Locality unknown. Auckland Museum.
4. Locality unknown. Dominion Museum neg. 814 B.
5. Locality unknown. Dominion Museum neg. 381.

PLATE 49

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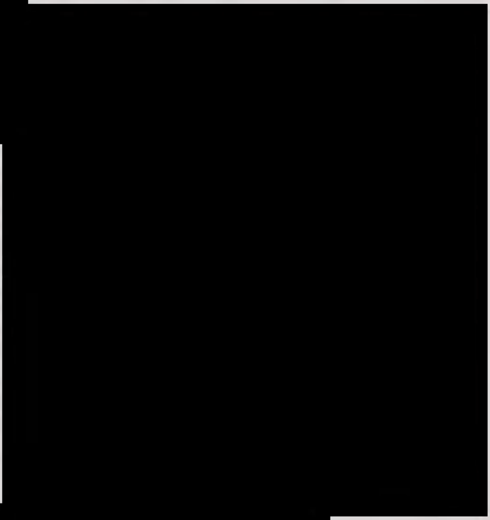

2

3

1. Hawkes Bay district. Dominion Museum neg. 376.
2. Poverty Bay. National Museum of Ireland.
3. Banks Peninsula. Canterbury Museum.

4

For cultural reasons, these images have been removed.
Please contact Auckland Museum for more information.

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4. Manutuke. Turanga House in Dominion Museum.
5. Banks Peninsula, Canterbury Museum.
6. Manutuke: house Turanganui a Kiwa.

1

For cultural reasons,
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have been removed.
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Auckland Museum
for more information.

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1. N.W. Lake Taupo. Dominion Museum.
2. East Cape district (A. Hamilton). Dominion Museum. neg. 7311.
3. Locality unknown. Dominion Museum 2417.
4. Locality unknown. Dominion Museum 2581.

For cultural reasons,
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5. Locality unknown. Dominion Museum 2418.
6. Locality unknown. British Museum NZ 146.
7. Hawkes Bay. Dominion Museum 287.
8. East Cape district (A. Hamilton). Dominion Museum neg. 380.

PLATE 51

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Auckland Museum
for more information.

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1. Locality unknown. Bernice P. Bishop Museum 1413.
2. Locality unknown. Dominion Museum 1991.
3. Wellington district. Auckland Museum 18426.2.
4. Locality unknown, now on *pataka* Te Oha. Auckland Museum.

For cultural reasons, these images have been removed. Please contact Auckland Museum for more information.

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5. Rotorua. Dominion Museum 2.1257.
6. Mayor Island. Auckland Museum 9900.
7. Locality unknown. Auckland Museum 22752.
8. Lake Taupo. Auckland Museum 24418.

PLATE 52

For cultural reasons, these images have been removed.
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1 Rotorua: house Rangitihi. Auckland Museum.
2. Locality unknown. Dominion Museum neg. 2.1267.
3. Te Kaha—*pataka*. Auckland Museum.
4. Te Kaha—*pataka*. Auckland Museum.

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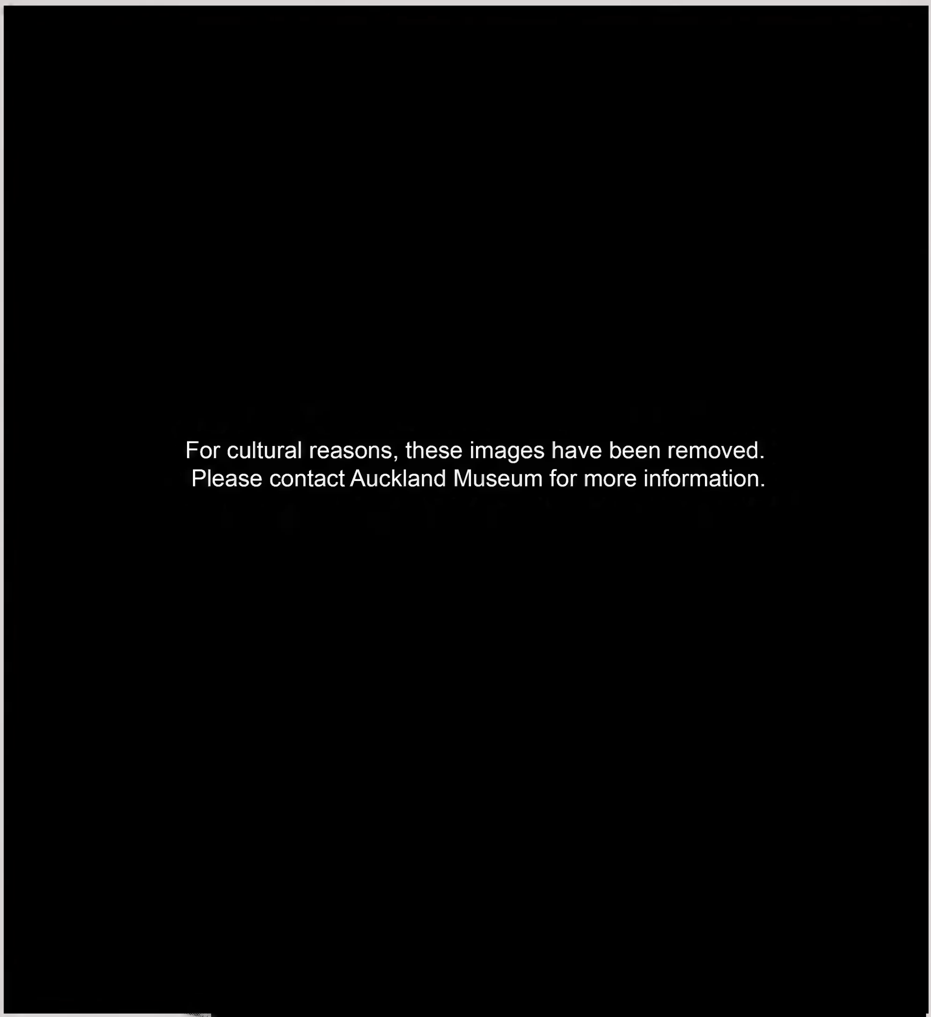
Please contact Auckland Museum for more information.

5. Locality unknown. Dominion Museum 8506.
6. Locality unknown. Dominion Museum 373.

PLATE 53



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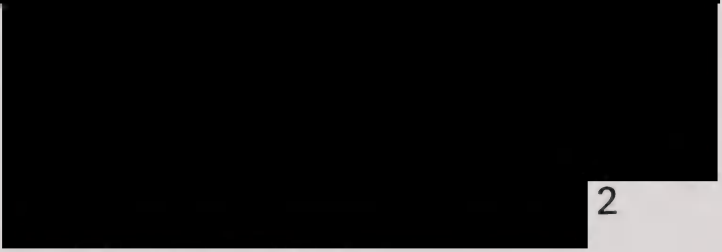

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1. Locality unknown. National Museum of Ireland.
2. Wairoa, H.B. Dominion Museum 4907.

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ARCHAEOLOGICAL EXCAVATIONS IN TWO BURIAL MOUNDS AT 'ATELE, TONGATAPU

JANET M. DAVIDSON
Auckland Institute and Museum

Abstract. Excavations in two earthen mounds are described. The structure of the two mounds and the method of interment within them are similar in spite of a noticeable difference in size. Both mounds were used over a period of time. Some evidence for earlier use of both sites for purposes other than burial was found. The status of burial mounds as field monuments in Tonga and their significance in Tongan prehistory are discussed.

The fieldwork described in this paper took place on Tongatapu from July to September 1964. The research was part of the Polynesian Prehistory Programme financed by the National Science Foundation of the United States and sponsored by the Bernice P. Bishop Museum, Honolulu (Emory 1962).

Tonga was not included in the fieldwork proposals of the original programme. However, a reallocation of funds was made to allow one archaeologist to spend a short time in Tonga, working in conjunction with a graduate student from the Australian National University, Mr. Jens Poulsen, who was already engaged in a twelve-month fieldwork programme there.

Poulsen had been in Tonga since September 1963 and was approaching the end of his fieldwork period. He had concentrated on shell midden sites, assembling a large collection of pottery and other artifacts and a certain amount of structural information (Poulsen 1967, 1968). While I could have excavated a similar site or sites, it seemed more useful to investigate quite different sites that would provide information about other activities in the past, but which might still yield some pottery by which they could be related to a general pottery sequence.

The importance of burial mounds of various kinds as field monuments in Tonga had been emphasized by more than one previous fieldworker (McKern 1929, Golson 1957). It is normally impossible to obtain permission to excavate such sites, however, and McKern's limited excavations had revealed relatively little information about them. In 1964, attention had been drawn to a number of small mounds, thought to be burial mounds, in the grounds of Tonga College at 'Atele, by Harold Hopkins, a former headmaster of the college. Many of these mounds exhibited characteristic traces of white sand, thought to be evidence of burial, and human bones had been recovered from one of them during gardening in the college plantations.

Rec. Auck. Inst. Mus. 6 (4-6): 251-286 March 14th 1969

The mounds are typical of countless others throughout Tongatapu, but offered the great advantage of being traditionally unknown. Neither the Honourable Ve'ehala, Keeper of the Palace Records, nor the people of the surrounding towns knew who was buried in them. For this reason it was possible to obtain permission to excavate in the mounds. I decided, therefore, to survey all visible mounds in the college grounds, and then to excavate at least one, and preferably two mounds, to test the assumption that white sand was indicative of burial, and to discover the structure of the mounds and the nature of the interments, if such proved to exist. It was not anticipated that permission to remove skeletal material from Tonga would be granted, and the excavations were planned on the assumption that all remains would be reburied. After the excavation had been completed, permission to remove remains for further study was received.

Eight weeks were spent on the excavation, and a further week was spent on refilling the trenches and packing material for shipment to New Zealand. I employed an interpreter who was capable of assisting with plans and section drawings, and four labourers who proved exceptionally good, even among Polynesians, who often show an aptitude for archaeological work.

Acknowledgements I should like to record my thanks to the Government of Tonga for permission to excavate, and to remove skeletal material to New Zealand for study. I should also like to thank Dr. K. P. Emory, of Bishop Museum, Hawaii, for initiating my visit to Tonga.

My work was greatly facilitated by the presence of an archaeologist already familiar with the local scene. I am deeply indebted to Mr. Poulsen and his wife Meike, who made a number of arrangements for me and were of assistance in innumerable ways. Mr. Jack Golson paid a brief visit to Tonga while I was there and provided stimulating advice on the interpretation of stratigraphy in site To-At-2.

At Tonga College, I should like to thank Mr. L. Lancaster, Acting Principal during the first part of my visit, for permission to excavate in the college grounds; the staff and pupils for kindly tolerating the disturbance in their midst; and, above all, Mr. J. Chambers, later Acting Principal, and his wife Lyn, for their wonderful hospitality and help.

To my crew, Sione, Siaki, Mesi, Salise and, above all, my interpreter, David Niumeitolu, I must say *Malo 'aupito* for their work.

The value of the excavation is greatly enhanced by competent specialist study of the skeletal material obtained. I should like to take this opportunity of recording my appreciation of Mr. Pietrusewsky's work. I learned a lot about physical anthropology during his visit to Auckland.

Mr. K. Peters drew the illustrations for this report and Mr. C. Schollum printed the photographs.

SITE SURVEY AT 'ATELE

The grounds of Tonga College consist of about 220 acres lying to the south of the main road in the centre of Tongatapu, just beyond the townships of Pea and Ha'ateiho (Fig. 1). The area is thus situated near the

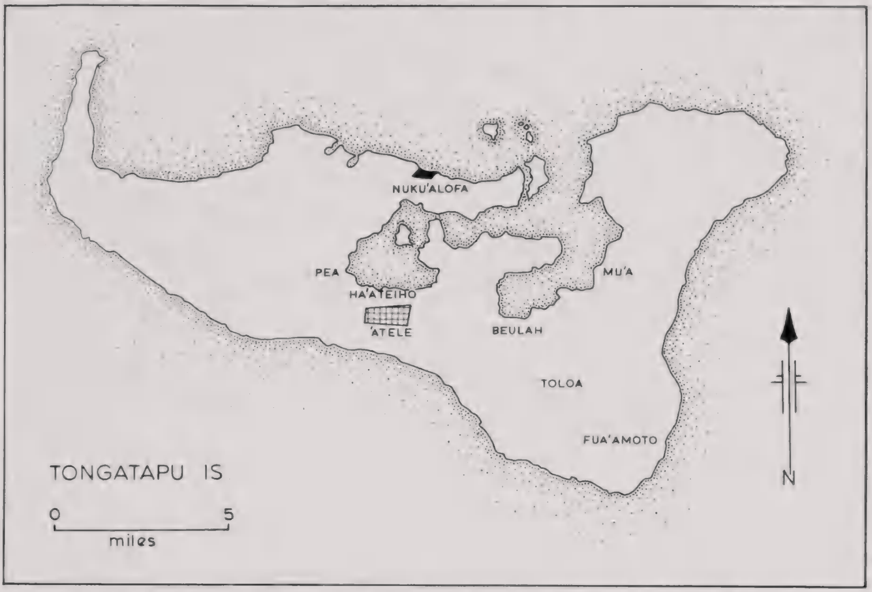


Fig. 1—Location of the 'Atele survey area on Tongatapu Island.

narrowest point of Tongatapu, a little over a mile from the raised southern cliffs, and less than half a mile from the edge of the shallow inner lagoon on the north side with its extensive shellfish beds. 'Atele is also close to the majority of pottery bearing midden sites excavated by Poulsen (1967, 1968), and a single site excavated more recently by Groube (personal communication).

The college grounds were thoroughly explored and all sites located were marked on an existing base map. Approximate diameters and heights were taken. The college is an agricultural training school, which grows its own food, and much of the total ground area is covered in crops of various kinds with some strips lying fallow. It is possible that some sites were not located in fallow strips, and also that some mounds have been destroyed in the area now occupied by playing fields, school buildings and teachers' houses. The existing mounds that were located are shown in Fig. 2. Mounds 14 to 17 were not exactly localised within the open pasture area. One of them is apparently a small burial mound, and the other three are very low mounds with no evidence of burial.

The mounds are of several types. There are three very large mounds in a group at the entrance to the college, one of which is still used for burials of members of a noble family. These mounds are named and their histories known; they far exceed in size any other site in the survey area.

FIG. 2—Distribution of archaeological sites at 'Atele.

Apart from these, eleven other mounds were found which showed probable evidence of use for burial in the form of white coral sand scattered on the surface. These mounds seemed to fall into two definite groups according to size: eight small low mounds corresponded to McKern's description of *tanuanga* or commoners' burial places, and three larger mounds with definite traces of a surrounding ditch, seemed more like chiefs' burial mounds or *faitoka,* as described by McKern (1929, pp. 30-31).

In addition, eight very low mounds without surface evidence of burial, were located. Potsherds were found on or near several mounds. Several areas of the plantation also yielded a few sherds, although there was no visible trace of a mound in the vicinity. In general, the few potsherds from 'Atele were small and very weathered. There were no decorated sherds, and very few rim sherds. Much of the ground is well cultivated, offering fair conditions for the finding of sherds. It is therefore unlikely that a major pottery producing site exists in the college grounds unless it has been destroyed or covered over in the area of the school buildings and playing fields.

Apart from the three named mounds near the main road, there are no large mounds at 'Atele in terms of the size range observable in Tongatapu. This situation is in contrast to some areas where a number of large mounds, not known to be burial mounds, exist. In the grounds of both Tupou College and Beulah College, as well as in many of the townships, there are mounds much larger than those at 'Atele.

Two mounds were selected for excavation, one representative of each apparent size group. The sites were numbered according to a modified version of a system widely employed by archaeologists in Polynesia. To- is for the island and At- for the district where the sites are located.

To-At-1 is typical of the smaller burial mounds at 'Atele and To-At-2 of the larger ones. Although both are situated in the plantation areas, neither had apparently been ploughed. Ploughing in the adjacent field had extended to the edges of To-At-1, but had ceased at the edge of the ditch surrounding To-At-2.

EXCAVATIONS AT TO-AT-1

To-At-1 was the first site investigated. It is a small low mound, situated just behind the water tower at the college (Figs. 2-3). Because of its small size, I hoped that it would prove relatively simple, and provide a training ground for the excavators before tackling the larger mound.

The site is approximately 40 m in diameter, and its centre reaches a height of only 80 cm above the surrounding ground surface. A grid of two metre squares, separated by one metre baulks, was projected over the site. Excavation commenced in a two-metre square (D-4) whose south-east corner was situated at the approximate centre of the mound. Two other two-metre squares to the west and two half-squares to the north were excavated, and the intervening baulks removed. In this way, an estimated

FIG. 3—General view, To-At-1.

quarter of the central burial area was excavated and two long sections from the centre to the outside of the mound obtained. Finally, a trench five metres by one metre was excavated through the edge of the mound on the south side to check the presence of a surrounding ditch. Altogether, 27 square metres were excavated in this mound (Fig. 4).

Excavation was by hand trowel and brush, following natural layers. Burials were photographed and drawn in position before being removed.

STRATIGRAPHY

It was immediately apparent that the site had been used intensively as a burial place, with the result that the stratigraphy in the central portion of the mound consisted of a complicated series of intercutting burial pits which had largely destroyed the original layers. In the adjacent squares, however, five main layers could be identified, relating to four occupations or uses of the site. On the edges of the mound, ploughing had apparently disturbed any layers that had existed, producing a uniform brown garden soil similar to layer 5, sometimes with an admixture of blacker soil resembling layer 4. Numbering of layers was restricted to those areas of the mound where a full sequence of layers could be observed.

Stratigraphy from the base upwards was as follows (Fig. 5):

Layer 5.—A brown garden soil, similar to that in the surrounding fields, which overlay the clay subsoil. It filled several deep postholes.

Layer 4.—A thin layer of blackened soil, shell, burned coral oven stones and considerable charcoal. Several postholes were filled with this material, and one large firepit and one smaller one were cut from it into layer 5.

Layer 3.—A thin layer of mixed soil and white sand, which filled a few postholes. The earliest burials on the site were derived from this layer, and the burial pits were partially filled with similar material.

Layer 2.—Sterile clay and soil used on the construction of the mound.

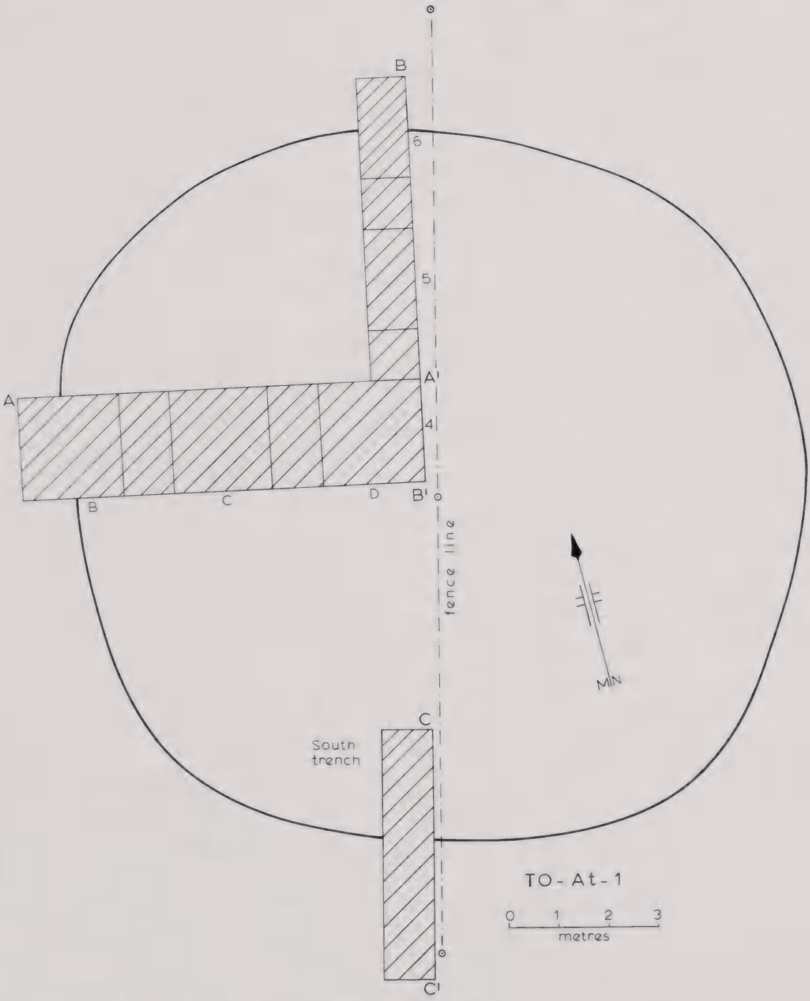


Fig. 4—Plan of To-At-1, showing area excavated.

Layer 1.—Mixed soil and sand very similar to layer 3. Burial pits dug from the surface of the mound were filled with similar material.

Two sections illustrating this sequence are presented in Fig. 5. Other sections in the central part of the mound showed more burial pits, and less of the major sequence of layers.

In square D-6, separate layers merged in an undifferentiated garden soil. There was no trace of a ditch surrounding the mound. In square B-4, however, a ditch was encountered. As this ditch could not be stratigraphically related to the mound structure owing to ploughing and merging of layers, the south trench was excavated to check the presence of a ditch there.

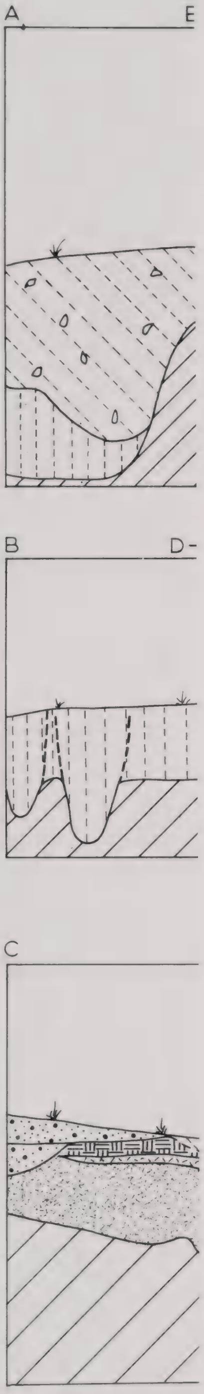
A ditch was also encountered in this south trench, and here it could be demonstrated that the ditch was almost certainly more recent than layers 4 and 5. It appears that the mound was initially constructed with spoil won from the surrounding ditch, which has since been filled, and its surface ploughed in such a way that its original relationship to the mound has been obscured. The posthole-like features in the fill of the ditch in the south trench are probably recent planting holes.

Occupation Sequence

1. A number of holes, resembling postholes, had been dug on the site, They penetrated the subsoil and were filled with material indistinguishable from layer 5. These holes were initially identified as postholes, but the excavated area was too small for any pattern to be identifiable. As there was no associated midden or artifactual material, the possibility that they were yam planting holes has to be kept in mind.

2. A more definitely domestic occupation succeeded. Further postholes had been dug. These were filled with the black midden material of layer 4, which accumulated on the surface of layer 5. This occupation appears to have been mainly a cooking one, with one large firepit uncovered in square B-4 and baulk, and a smaller one in square D-5. The presumed postholes probably represent a house structure whose overall form cannot be reconstructed because of the limited area excavated. The thinness of layer 4 suggests an occupation of relatively short duration.

3. After the build-up of layer 4 ceased, the first burials were made in the site. These antedated the construction of the mound itself. Pits were dug from the existing ground surface (the surface of layer 4), the bodies placed in them and partially covered with white sand, and the pits filled in. These burials were not all contemporary, but followed one another over a period of time. As a result of the repeated digging and filling of graves and the bringing of white sand to the site to cover burials, layer 3, a mixed soil and sand layer, accumulated on top of the midden layer 4. During this period, at least one house was built on the site and possibly several successive houses. Again, these structures are represented by postholes, which did not normally penetrate the subsoil, but were visible on the surface of layer 4, and in the sections. A house may have been present before the first


A
E
B
D-
C

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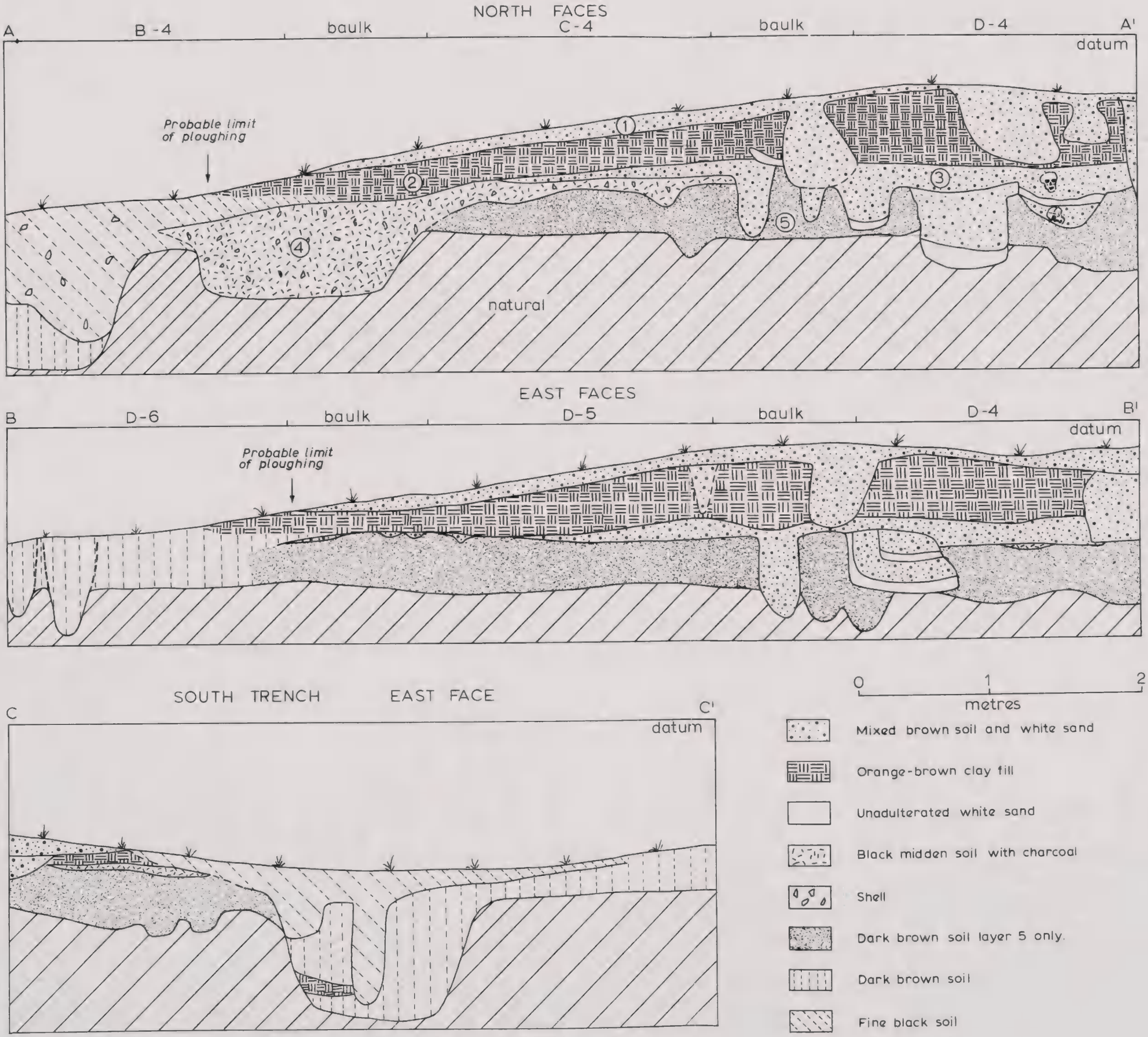

FIG. 5—Principal sections, To-At-1.

interments took place, in which case they would probably have been in the floor of the house. The postholes may also represent a special structure or structures built over the burials.

4. The final phase of use of the site related to the construction and use of the mound for further burials. A low mound was constructed with spoil obtained from a circular ditch partly surrounding the mound, but open to the north. The mound appears to have been built exactly over the centre of the previous burial area. The surface of the mound was then used intensively for burials. On the surface, a mixed layer of sand and soil very similar to layer 3 built up. A few postholes, filled with layer 1 material, located on the surface of the mound, probably relate to a protective structure erected over the burials rather than to a dwelling house.

Features

The only features encountered in this site were the burial pits themselves, the trench surrounding the mound, the postholes of various periods, and the two firepits. There were no other pits. Postholes ranged up to about 60 cm deep and from 20 to 40 cm in diameter. It is possible that some, particularly the earliest and those on the perimeter of the site, are yam holes. The larger firepit was 150 cm in diameter and about 60 cm deep. The smaller was about 70 cm in diameter and correspondingly shallower. Neither contained large concentrations of coral oven stones, but both did contain more charcoal than the remainder of layer 4.

The general dimensions and shape of the surrounding ditch are visible in the sections (Fig. 5). The extent of the ditch could not be determined as it was not visible on the surface. The burial pits are described below.

Midden

The midden content of layer 4 appeared fairly simple. A cursory analysis was made on the site, but no samples were brought back to New Zealand. All shell was collected from layer 4 for examination before being discarded. Coral and other oven stones were collected from some squares only. A crude analysis of midden content is given in Tables 1 and 2.

TABLE 1

QUANTITY OF STONE AND SHELL BY WEIGHT IN SOME AREAS OF LAYER 4, TO-AT-1.

	B-4	large firepit	Baulk B/C-4
stone - - - - - -	5 lbs	$5\frac{1}{2}$ lbs	6 lbs
shell - - - - - -	1 lb	1 lb	2 lbs

TABLE 2

ANALYSIS OF SHELL BY NUMBER IN LAYER 4, TO-AT-1

	B-4	C-4	B/C-4	large firepit	D-5	small firepit
Gafrarium gibbosum -	74	925	710	175	150	3
Anadara sp. - -	1	1	5	1	—	2
Pinctada sp. - -	40	22	30	9	x*	3
*Turbo sp.*** - -	—	3	—	—	—	1
Other - - -	3	13	5	2	—	—

* Present in minute quantities.
** Represented only by opercula.

Coral oven stones were predominant, but a number of unworked pieces of volcanic rock were also found. Samples of this were retained.

Artifacts

Artifactual finds from this site were extremely limited. No pottery was found in association with layer 4. It is possible that a very occasional sherd may have been missed because of the workmen's inexperience. However, all the workmen were familiar with Poulsen's excavations and alert to the possibility of finding pottery. Only two sherds were found in the site, one in the fill of the ditch in B-4, and one in the fill of the ditch in the south trench. Both were plain, very worn, body sherds. An adze fragment, too small for its shape to be inferred, was also found in the ditch in the south trench.

These items could be eroded from the fill of the mound or from the surrounding fields. It seems certain that though layer 4 was a cooking occupation, no pottery was associated with it. Layer 4 may represent a fairly transient occupation or the cooking of a few meals at an agricultural rather than a dwelling site, in which case the absence of pottery would be understandable.

Burials

Thirty-eight separate interments, comprising some forty-six individuals, were encountered in To-At-1. The majority were located in D-4 and the adjoining baulks. Only seven extended into C-4 and D-5. Many burials were completely excavated, but some extended beyond the limits of the excavation. Because of the large number of burials in a small space, many had been disturbed and sometimes bones that had been disturbed were reburied in a fresh grave along with the individual for whom it was intended. Condition of the bones varied greatly.

It was not possible to relate every burial to every other in a chronological sequence. However, they could be divided into a number of groups, and the groups arranged in order, from oldest to most recent, as follows:

Group A, prior to the construction of the mound—
- subgroup 1: (oldest) 34, then 30 and 29.
- subgroup 2: 27, 28, 24, 23, 22, 21, 20 (27 and 28 are contemporary, 23 is more recent than 22).
- subgroup 3: 16, 17, 18, 19.
- subgroup 4: 10, 11, 12, 13, 14 (12 is more recent than 10 and 11).

Group B, from the surface of the mound—
- subgroup 5: 8, 9, 36, 37.
- subgroup 6: 2, 3, 5, 7, 32, 33, 35.
- subgroup 7: 1, 4, 6, 31, 25, 26.

There was some variety in burial pits. They were mostly oval or rectangular pits; one (29) which contained disarticulated adult bones and two disarticulated child skeletons (Fig. 6) was almost circular. The deepest was about 80 cm deep, while some were hardly pits at all, merely shallow

FIG. 6—Disarticulated remains, burial 29, To-At-1.

scooped depressions. The majority of relatively undisturbed adults were in pits about 50 cm deep, with immature individuals in shallower pits, only about 30 cm deep. Many young children were unceremoniously interred in minimal pits, although burials 4 and 26, which included adult remains, were also very near the surface and had suffered accordingly.

Most of the burial pits were straight sided, but one or two had noticeably undercut sides. There did not appear to be any chronological significance in this. One of the earliest and one of the latest pits had this feature. None of the pits was sharply rectangular, all having rounded corners, and rounded junctions between base and sides. The deepest pits were the earliest in both group A and group B. Later burials in each group were shallower, probably because of the increasing likelihood of disturbing existing burials.

There were several instances of multiple burial. Most interesting is burial 29, which consisted of three disarticulated skeletons at least, one adult and two children, buried as three separate bundles in one pit (Fig. 6). As this is one of the first burials on the site, it cannot be due to disturbance on this site. The remains would appear to have been transferred from some other place and carefully reinterred here.

Another definite instance of multiple burial was burial 1 in which two young children were buried one on top of the other in a single pit. Burials 27 and 28 were in a single pit, but it was not clear whether 28, a fragmentary child's skeleton, was the reinterred remains of an earlier burial disturbed by 27.

Other instances of burials assigned one number, but including remains of more than one individual, were almost certainly due to prehistoric disturbance and reinterment. These included burials 4, 10, 13 and 21. Burials that had obviously been disturbed during use of the site and were incomplete or badly fragmented when excavated included 8, 11, 15, 17, 18, 20, 22 and 23, 25, 32, 36 and 37.

An additional problem was disturbance of the excavation by nocturnal visitors, presumably from neighbouring townships. Burials 6, 19 and 34 were disturbed in this way. Finally, mixing and loss after excavation resulted in the non-availability of 15 and 24 (both infants) and part of 14 for specialist study.

Age and sex of individuals from this site are discussed in the following report. Suffice it to say that the population structure appears to be unusual for this site, with a high child mortality rate. All the evidence suggests that a sufficient sample was obtained from this mound, and there is no reason to believe that the unexcavated portion would contain a significantly different proportion of mature individuals.

Ten burials were so disturbed, or had never been articulated, that their position and orientation could not be determined. These were 29, 4, 8, 10, 12, 23, 24, 25, 32 and 33. The last two were only partly exposed by excavation and appeared to have been disturbed by postholes dug from the surface of the mound.

Two further burials whose position could not be satisfactorily determined were burial 20, of which only the edge was encountered, and burial 21B. Both were apparently oriented with head to the east.

Orientation was assessed as the approximate alignment of the body in the direction of the head, and varied between NNE and SE with the exception of burial 37, an infant oriented with head to the south, which was also exceptional in being the only "crouched burial". Other orientations were as follows: NNW three; N twelve, NNE five; NE three; ENE nil; E four; ESE two; SE two. There appeared to be no significant variations between subgroups, examples from each being fairly widely distributed within this range. Nor was there any noticeable difference between orientations of mature and immature individuals.

The majority of burials, both adult and immature, were in a supine position. The remainder were on their sides. None was in a prone position. With the exception of burial 37, all were extended. Of those whose position could be determined, there were seventeen supine (Fig. 7), three right sides, five left sides, one left turned slightly towards prone (Fig. 8), and one left turned slightly towards supine. The supine position was used

FIG. 7—Portion of burial 14, To-At-1.

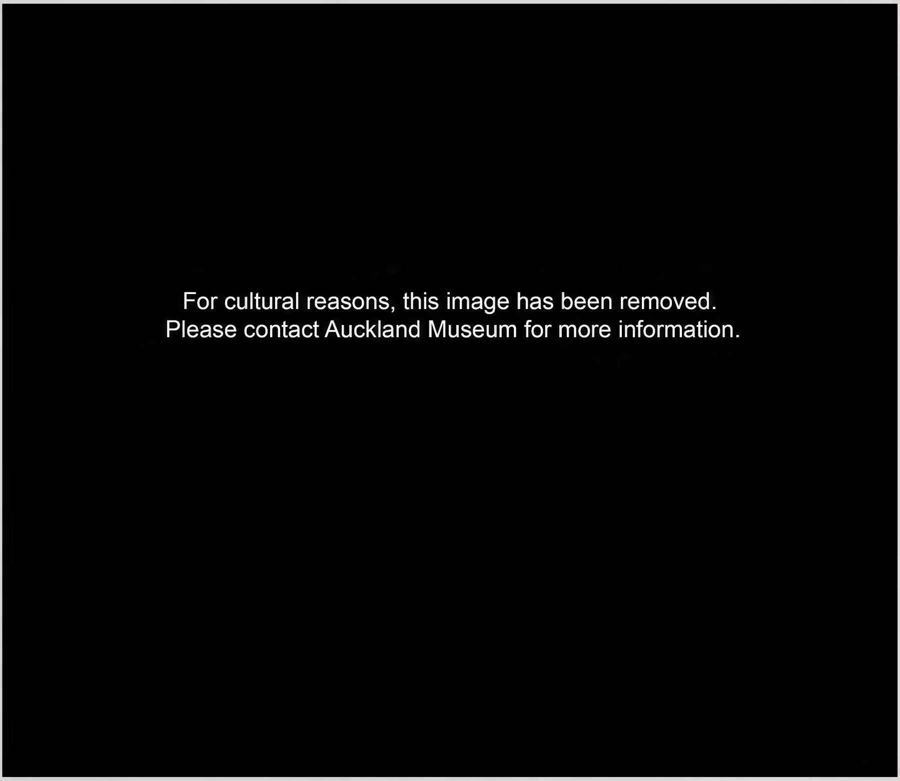

FIG. 8—Burial 12, To-At-1.

throughout the sequence; representatives of every subgroup were in this position. With the exception of burial 12, however, an individual from subgroup 4 buried on its left side turned towards a prone position, all burials that were not supine belonged to the more recent Group B. There appeared to be no difference between the positions of adults and children.

There was considerable variety in arm position. Some had both arms parallel to the sides, some had crossed or folded arms and some had hands doubled up to the chin. There were other variations, one arm folded across the body and the other extended, or doubled up to the chin. There was less variety in the disposition of the legs, however, which were either straight and parallel, slightly bent at the knee, or crossed at the ankle.

There were no grave goods. The amount of white sand in the grave fill varied considerably. The pit of burial 6 was almost completely full of sand, while others had only an inch or two, or none at all. In some cases a dark stain was noted in the sand. This is thought to have been due to the disintegration of black tapa cloth wrapping, noted by early visitors to Tonga (Wilson 1799) and still used in Tongan burials. There appeared to be little correlation between age at death and the presence of quantities of sand and dark staining. Some children, particularly, were buried with quantities of sand, in which a strong dark stain was noticeable.

Dating

Samples of bone from burial 34 were submitted for radiocarbon dating of collagen. Although the sample of bone submitted was thought to be more than adequate, insufficient collagen was obtained for reliable dating. The laboratory quoted a date of less than 1200 years old (a reading of almost modern activity taken to three standard deviations) (GaK-1203, Kigoshi pers. comm.).

Summary

The primary use of this site throughout most of its history was as a burial place. Burials were made both from the surface of the mound, and from the previously existing ground surface prior to the construction of the mound. Apart from the construction of the mound itself, there was apparently no change in burial practice, and the positioning of the mound over the centre of the previous burial area suggests continuity of use.

The use of the site for burial was preceded by a cooking occupation, probably transient, but of sufficient importance for the importation of at least some volcanic cooking stones. An earlier use of the site, of uncertain nature, is evidenced by holes, resembling postholes, penetrating the subsoil.

EXCAVATIONS AT TO-AT-2

The second mound selected for excavation is significantly larger than To-At-1 (Fig. 9) and differed from it in being encircled by a visible ditch. In terms of size, this site was well within the range described by McKern

FIG. 9—General view, To-At-2.

for *faitoka* (chiefs' burial places) and it was thought that it might prove to contain the coral slab vault supposedly characteristic of *faitoka*.

A long trench, one metre wide, was laid out through the entire mound, and excavated in several sections, three sections on the north side first, followed by three on the south side. Eventually, intervening baulks were removed so that a complete section through the mound was obtained. At either end of the main trench an extension was opened up in an attempt to locate postholes or other features on the outer edge of the encircling ditch.

A second trench, also one metre wide, was set out at right angles to the first. Only the outer portions of this trench were excavated, and were designated the east and west trenches. They were excavated to obtain further information about the size and alignment of the submound discovered in excavating the principal trench, rather than to obtain further data on burials.

A grid of one-metre squares was imposed on the site, numbered along a north-south axis and an east-west axis. Each excavated square was numbered according to the intersection of grid lines at its northeast corner, and all burials were plotted in relation to such points (Fig. 10).

The two trenches provided cross-sections through the mound (Fig. 11). Both were excavated completely to underlying subsoil.

Because of the occurrence of potsherds in the area immediately surrounding the mound, and the lack of a recognisable occupation layer beneath the mound itself, two test pits were excavated in areas most productive of surface sherds. These were named test pits A and B (Fig. 10). Test pit A was found to be unrewarding and was not extended. Test pit B, however, revealed a pit which was partly filled with shell midden. Accordingly, excavations in this area were extended towards the mound itself, and eventually to a point where the relationship between the numerous pits in the area and the ditch encircling the mound could be investigated. The whole area, which was diagonal to the main site grid, was labelled Excavation B.

Stratigraphy of the Mound

In the area of the mound itself six main layers could be determined. From the bottom upwards, they were (Figs. 11-12):

Layer 6.—A thick layer of dark brown soil, which filled a large shallow pit and at least one posthole beneath the mound itself. In the main trench, two subdivisions of this layer could be identified, a harder browner zone at the base, and a softer blacker zone nearer the surface. This layer contained most of the potsherds found in the mound, and very occasional shell and fragments of turtle bone.

Layer 5.—A thin layer of mixed white sand and soil.

Layer 4.—A mixed fill of dark brown soil and more orange clay derived from excavation in the immediate vicinity.

Layer 3.—A mixed layer of white sand, and material similar to layer 4.

Layer 2.—A fill consisting largely of hard orange subsoil won from the surrounding ditch and forming the upper layer of the mound.

Layer 1.—Mixed clay, soil, and white sand.

While the stratigraphy was very clear in the centre of the mound, the same problems of merging layers on the fringes of the site were encountered as had been experienced at To-At-1. As all layers were composed of similar materials, developed on the same subsoil, and in some cases redeposited, it was very difficult to separate them where they were not separated by the unmistakable scatter of white sand on a surface that had been used for burials. This problem arose particularly in describing the fill of the two ditches. The inner ditch clearly antedated the construction of the mound in its final form, but its own fill could not be clearly related to layer 4. As is often the case with such ditches, the fill appeared to be derived partly from layers 6 and 4, and partly from soil outside the submound area. The sections presented are slightly simplified, in that all the soil lenses of the major layers and ditch fills are not shown.

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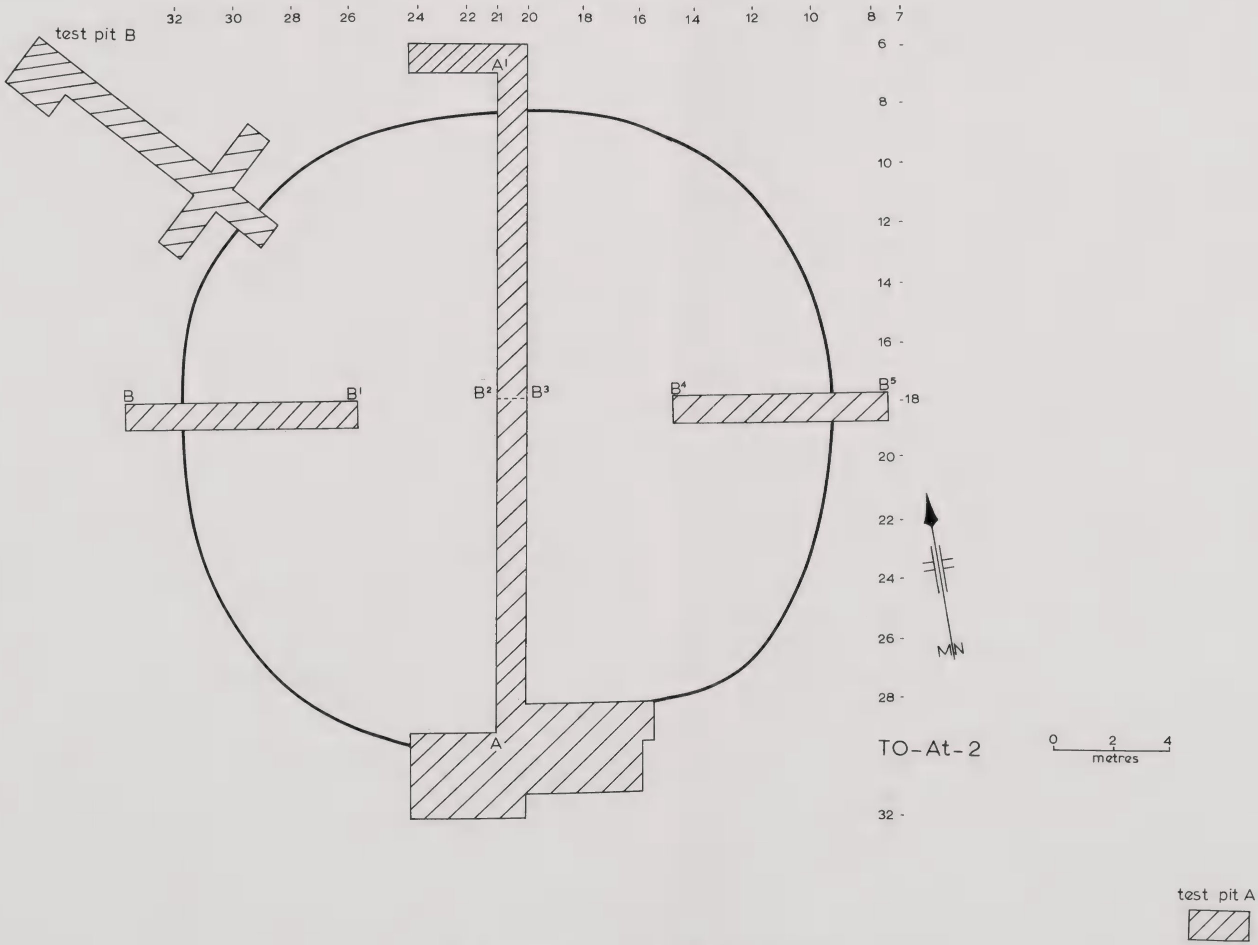
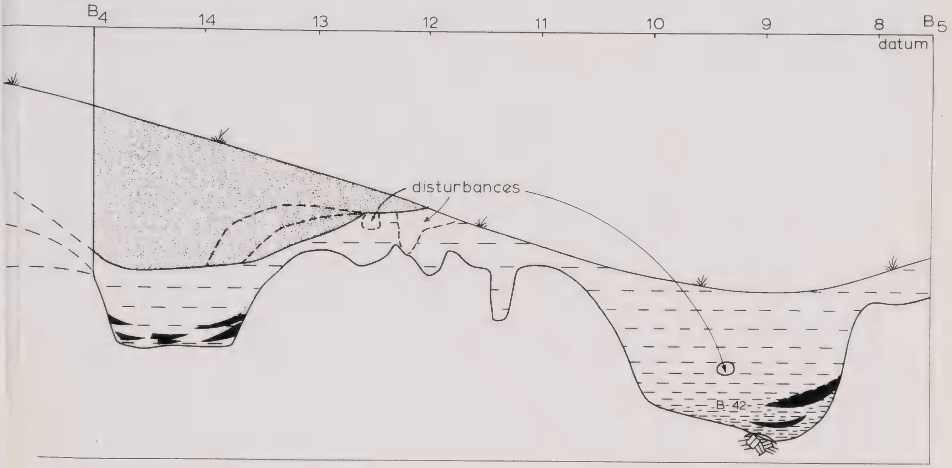


FIG. 10—Plan of To-At-2, showing excavated areas.


B4
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13
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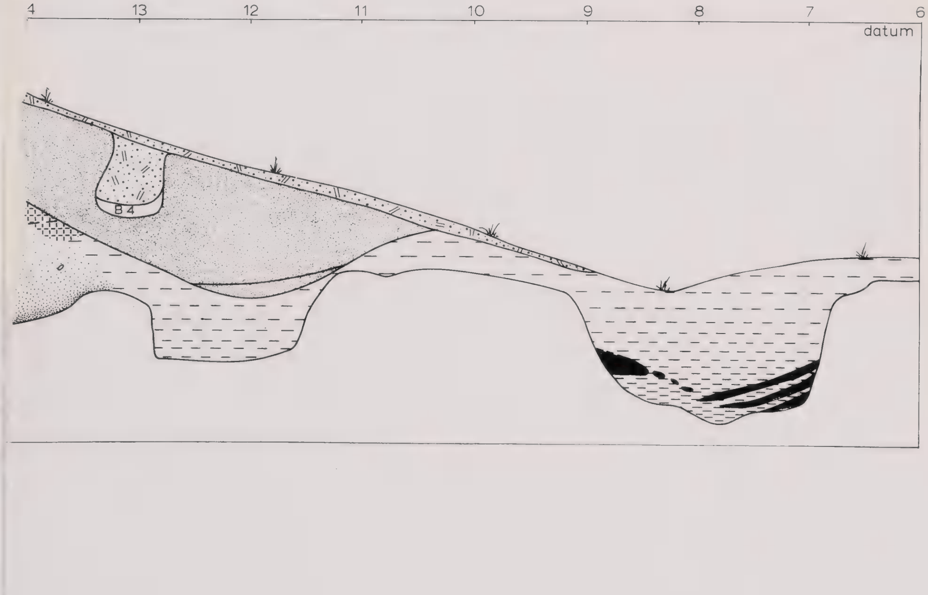
4
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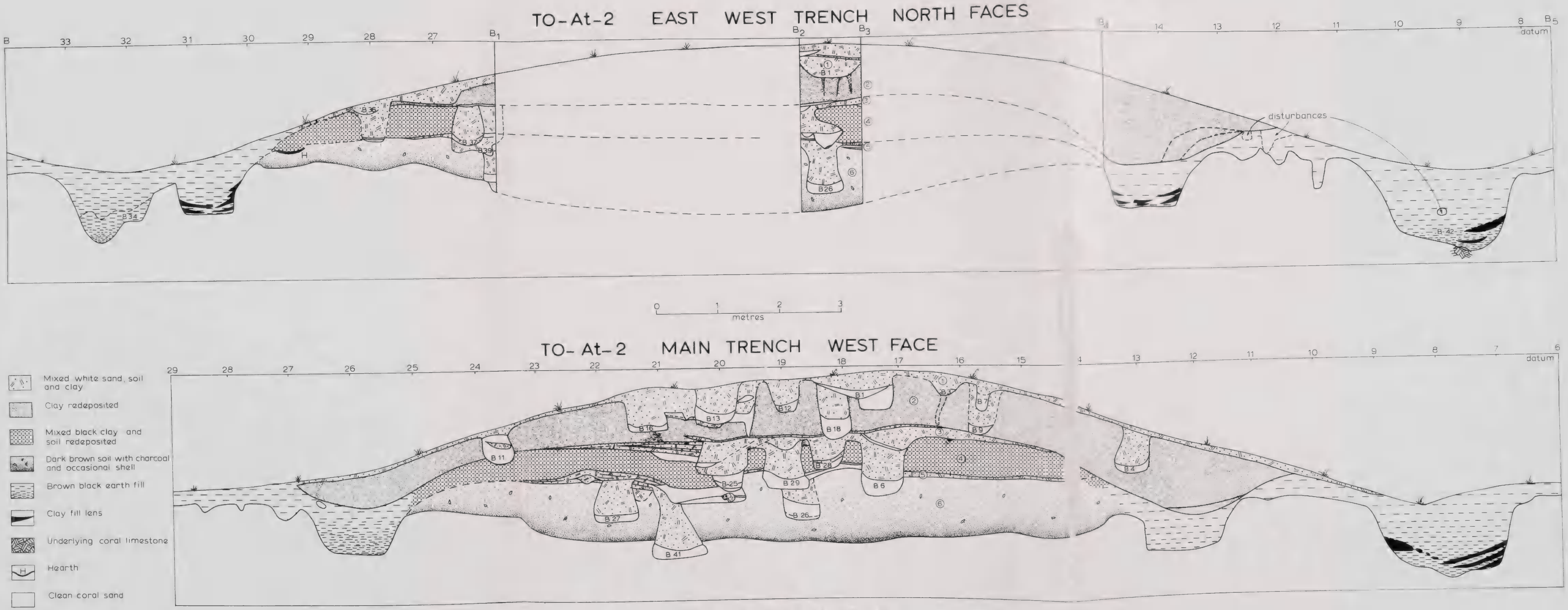

FIG. 11—Principal sections, To-At-2.

FIG. 12—Main trench, To-At-2, looking north, showing west face, part of Period 1 pit (in right foreground) and surrounding ditches of Periods 3 and 4.

SEQUENCE OF MOUND CONSTRUCTION AND USE

1. A large shallow pit, and at least one posthole, indicate an initial occupation of the site not concerned with burial. Little of this was revealed in the excavated area. These features are filled with layer 6.

2. The features of the initial use of the site were infilled, possibly deliberately, and the surface raised again to a level the same as, or slightly higher than the surrounding ground surface. The first burials were made from this surface. These burials were placed in pits, at least one of which had markedly undercut sides, partly covered with white sand, and filled.

3. A small mound approximately the same size at To-At-1, but more oval in shape, was formed from spoil won from a surrounding ditch, and new burials made from its surface. These burials were also in pits, though some were much shallower than those of the earlier phase. Sufficient time elapsed for the surrounding ditch to become largely filled in.

4. The mound was enlarged by excavating a second and larger surrounding ditch outside the earlier one, and heaping the spoil from it on top

of the existing submound. Further burials were made from the surface of the enlarged mound.

5. A few further burials in the sides of the mound and in the fill of the surrounding ditch may have been added hastily and unceremoniously at a later time.

Features

Few features were encountered in the area of the mound itself. Pits revealed in Excavation B are discussed separately below.

The only features definitely belonging to Period 1 were the large shallow pit, and one posthole. Edges of this pit were found at two points in the main trench, and in the west trench. They are shown on Fig. 13, together with a possible reconstruction of the outline of the pit. One

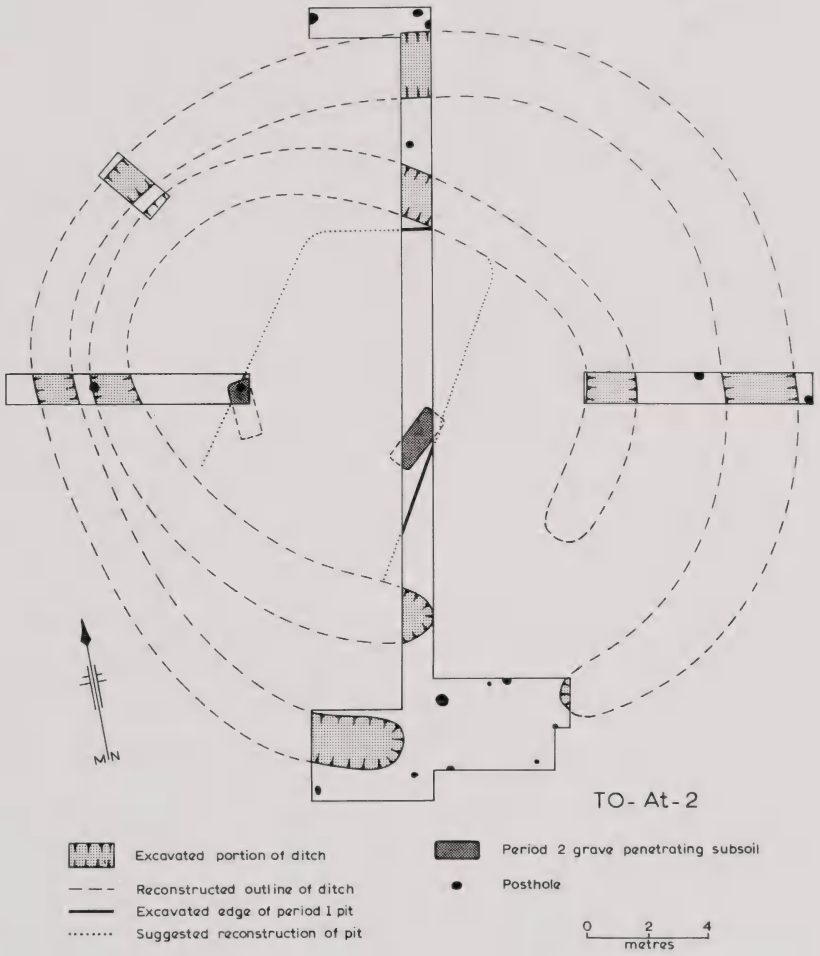

Fig. 13— Plan of features penetrating the subsoil, To-At-2, and suggested reconstruction of the Period 1 pit and the ditches of Periods 3 and 4.

posthole was found in the edge of this pit, in the west trench. It is clearly sealed by a Period 2 burial which also penetrated the subsoil at this point. The posthole may actually be associated with the pit.

No interpretation of this structure can be advanced. It does not appear to be a natural feature, however. Its floor is perfectly smooth in contrast to the uneven and disturbed surface of the subsoil elsewhere in the site, and its edges, although low, are clearly defined (Fig. 12). With so limited a portion uncovered, its actual size and shape can only be guessed, but it would appear to be at least 10 x 7 metres, although only about 20 cm deep.

The presence of the posthole suggests that a structure could have been associated with the pit. Either an agricultural or a dwelling function would appear to be indicated, probably the former.

One other posthole almost certainly belongs to Period 1. It is the single posthole between the inner and outer ditches in the northern part of the main trench (Fig. 13).

Period 2 is represented only by burial pits which do not appear to differ from those of To-At-1, or from later periods on this site.

Periods 3 and 4 are represented by the submound and mound, with their surrounding ditches, burial pits, and postholes.

The excavated portions of the surrounding ditches and their reconstructed forms are shown in Fig. 13. Both ditches are incomplete and open towards the southeast.

Several problems arose in the identification of postholes. All over the site (except in the floor of the Period 1 pit) were numerous minor disturbances of the subsoil, often of irregular shape, and usually shallow. These could be caused by gardening, root disturbance or burrowing animals of various sizes. Quite substantial disturbances of the soil in the east trench were due to ant colonies. Most disturbances were not accepted as postholes. There appeared to be a fairly clear division between regular features penetrating at least 30 cm into the subsoil, often considerably more, and features which are shallower. The former were tentatively identified as postholes, although the possibility of yam holes must be kept in mind. It was not possible to relate these presumed postholes stratigraphically to either phase of mound construction, although it is probable that if they relate to the mound at all, it is to Period 4. The position of the presumed postholes as shown on Fig. 13 suggests that there could have been a surrounding fence on either the inner or outer side of the ditch in Period 4. There is little evidence in the excavated area for a fence surrounding the submound.

Associated Material

Several potsherds were found in the mound and in the extensions at either end of the main trench. A single adze fragment was found in the fill of the outer ditch in the southern extension. Occasional fragments of shell and non-human bone were found in layer 6 and in the fill of the

ditches. There was very little midden or artifactual material in the site altogether, and no occupation layer comparable to layer 4 at To-At-1 was located.

Twenty-five sherds were found in layer 6 beneath the mound. All were undecorated and very weathered. Two were rim sherds. One sherd was found in layer 2, four in the fill of the Period 4 ditch, and twenty-two in the undifferentiated garden soil in the northern and southern extensions of the main trench. A further five sherds from this site are not precisely localised. There were no rim sherds other than the two from layer 6, and all sherds are plain and well weathered. They appear to have been lying around near the site prior to its use for burial, but no occupation layer has been identified as their source.

The adze fragment from the fill of the outer ditch is of interest as it is the butt end of a small adze of triangular section, probably with apex to front. It is flaked, but the median ridge is ground, suggesting apex to front. This type of adze is rare in Tonga. Its age is difficult to determine. Its context in the site is late, in the fill of the outer ditch, but like sherds from similar contexts it may be derived from the surrounding garden soil and be older than the site.

Burials

The burials in this site were not as close together nor as disturbed as those from To-At-1. Even here, however, some burials had disturbed earlier ones, resulting in intrusive bones in burials 20, 21 and 30. Burial 1, in the centre top of the mound, consisted of a number of successive interments on one spot, resulting in considerable mixture of bones.

The narrower trench excavated meant that very few complete burials were exposed. In the centre of the mound, numerous burials were merely touched upon at the sides of the trenches. Burials were sufficiently numerous and close to one another to render extensions on either side of the trench at the centre of the mound impracticable. An exception was made in the case of the particularly well preserved and relatively isolated burial 4, however.

Towards the close of the excavation, some difficulty was experienced with crumbling of the sides of the trench, owing to the quantity of loose sand present in the faces. Many of the unassigned bones from this site are the result of erosion of the faces revealing other burials.

Unfortunately, the early burials in the centre of the mound were not well excavated, because of the danger that the walls of the excavation would collapse. This is probably the reason for the presence of intrusive bones in these burials. Under the more controlled conditions which existed during excavation of upper layers, this problem did not arise.

Burials 30 to 36, located in the west trench, were all rather shallow and consequently in poor condition. A further perplexing feature of this site was the discovery of several badly crushed burials in the fill of the outer

ditch. Although these were not in good condition, they appeared to have been placed in the ditch in a position of articulation, rather than to have eroded out of the fill of the mound. They lacked recognisable grave pits, and white sand covering.

Since excavation, all bones from burials 1B (an infant) and 12 (an adult) and the skull of the important burial 4 have been lost. While such losses may seem inexcusable, they are at least partly due to souvenir hunting, rather than to negligence on the part of the excavator.

Most burials were in pits very similar to those at To-At-1. The range in pit size and shape, and in quantity of white sand, is clearly shown in Fig. 11. Pits which do not appear in the illustrated sections did not differ from those illustrated.

Because the burials in this site were more spread out, they cannot be placed in sequence as satisfactorily as those from To-At-1. They can, however, be assigned to the major periods of use of the site as follows:

Period 2: 26, 27, 39, 40, 41.

Period 3: 5, 6, 20, 21, 22, 23, 25, 28, 29, 37, 38.

Period 4: 1, 2, 3, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 30, 31, 32, 33, 35, 36.

Period 5: 24, 34, 42.

Although several burials in this site contained bones from more than one individual, there were only two instances where two individuals appeared to have been buried deliberately at the same time in the same grave. Burial 13 consisted of parts of three individuals. Number 13C was an earlier burial whose grave pit had been almost entirely destroyed by the later interment of 13 and 13A, two adults buried at the same time face to face (Fig. 14). The other certain double burial was burial 40, located in the west trench, where two adults had been buried one on top of the other in a deep but narrow grave. This burial was also interesting in that fragments of what appear to be tapa cloth, now hardened to a form like papier mâché, were found in association with 40A, the lower of the two individuals. Only the end of this burial lay within the area of the excavation (Fig. 13) and unfortunately little skeletal material was removed for study.

Of the remaining complex burials numbers 1 and 13C involved reuse of the same location on top of the mound, 24 consisted of fragmentary remains in the fill of the outer ditch, and 30 was excavated as a bundle of assorted bones, the only example of clearly disarticulated remains in the main portion of the mound. Two of the Period 3 burials in the middle of the mound, 21 and 22, involved superimposed but not contemporary burials in the same place.

Orientation of skeletons from this mound is best described by Periods. Period 3 and 4 burials show a fairly consistent pattern of orientation with greater diversity in Periods 2 and 5.

FIG. 14—Period 4 burials, To-At-2. Burial 12 (in foreground) and 13 (at rear).

The five Period 2 burials whose orientation could be determined were widely distributed as follows: WSW one; N two; ENE two. These are the earliest burials on the site and antedate the construction of the mound.

With the building of the submound, orientation became more consistent: SE eight; E three; NNE one; N one. The last two were both in the west trench. The pattern of orientation for Period 3 therefore can be interpreted either as predominantly SE-E or as feet towards the centre of the mound.

Among Period 4 burials, orientation became even more consistent: ENE two; E seven; ESE three; SE twelve; SSE one. It is worth noting that both Period 3 and Period 4 burials tend to be oriented towards the gap in the surrounding ditches.

The final burials of Period 5 are again more varied: NW one; N one; SSE one.

There seemed to be no significant variation in orientation between adults and children, nor any significant correlation between orientation

and position, except that there appeared to be a tendency for those oriented towards the north to be lying on their left sides, thus facing east.

At this site, as at To-At-1, the supine position was most common, except in Period 2. Only one of the Period 2 burials was in the supine position, with two left side and two right side. Of Period 3 burials, however, eight were supine (of which three were slightly tilted to the right). There were three right side and one left side. Period 4 burials included a number of immature individuals. Position, where it could be determined, was as follows: supine fourteen (three immature); probably supine four (two immature); supine tilted to the right one (immature); right six (two immature); probably right one (adolescent); left two. The possible totals for Period 4 burials then are supine nineteen, right side seven, left two. In Period 5 burials there were two supine and one left.

In this site also there was some diversity of arm positioning. Most burials in a lateral position have both hands doubled up to the chin, and in one case (burial 40) it was clear that tapa cloth and/or mats had been wound tightly round the body with arms inside. Among supine burials, the arms were usually extended, but there are instances of folded arms, and of one hand under the chin. Only one supine burial (from Period 2, burial 41) had both hands under the chin.

Legs were normally extended, sometimes slightly bent at the knee, with one case of crossed ankles.

The majority of burials in this site were in pits and covered with white sand. Several infants or young children were in very shallow pits, but most pits were of reasonable depth.

There were thirteen exceptional burials which lacked white sand or recognisable pit. Four burials without pits were encountered in the main trench, burials 10 and 19 (adults) and burials 3 and 9 (children). Six more of the exceptional cases were in the west trench, where a number of shallow and apparently unceremonious burials were found. Of these, burials 30 and 36 were in shallow pits with little or no trace of white sand, while numbers 31, 32 and 33 had little trace of a pit and no white sand. These five are all from Period 4. Burial 39, a Period 2 burial, was in a clearly defined pit, but lacked all trace of white sand. Finally, the three late burials in the fill of the outer trench, numbers 24, 34 and 42, lacked recognisable pits and white sand covering.

The dark stain, thought to be indicative of black tapa cloth wrapping, was observed in a fairly small number of burials in this site. Only one of the numerous Period 4 burials, 1C, was noted as having this characteristic. On the other hand, four Period 3 burials, 20, 22B, 23 and 29, had pronounced black stains. Of the Period 2 burials, 41 had a noticeable black stain and, as noted above, 40A had what appeared to be fragments of tapa present in the sand. All the burials in this site that had black staining were adults, in contrast to To-At-1 where staining was also present on several immature individuals.

There were no durable grave goods.

The population from this site is described in the following report. Age and sex distribution appear to be more normal than at To-At-1.

Dating

Two samples of bone from this site were submitted for collagen C14 dating. A left femur and right humerus from burial 41, a Period 2 burial and probably the earliest burial on the site, gave a determination of 770 ± 200 years before 1950 (GaK-1204), and a left tibia and fibula from burial 10 (Period 4) gave a date of 390 ± 110 years before 1950 (GaK-1205). Collagen recovered from these bones was barely sufficient, hence the relatively large error.

The dates set the mound fairly clearly in the prehistoric period, and indicate that its use was spread over a considerable time. Allowing for one standard deviation, burial 41 falls between the 10th and 14th centuries, and burial 10 between the 15th and 17th centuries. Allowing two standard deviations, burial 41 falls between the 8th and 16th centuries, and burial 10 between the 14th and 18th centuries. If the true age of burial 10 falls close to the upper limit of 1780 A.D. it is possible that contact with Europeans was affecting the mortality rate during the later stages of mound use, though unlikely that miscegenation would have taken place to any extent. The chances are, however, that the mound is truly prehistoric.

Summary

The history of the burial ground may be summarised as follows.

First use of the site is little known, but included a large shallow pit, and at least one posthole. Virtually no midden material is associated with this occupation, suggesting an agricultural rather than a residential use of the site. The first burials were made from the surface of a soil which filled the earliest features. Although there was no mound at this time, the burials were in pits, sometimes with undercut sides, and covered with white sand. One of the early burials shows dark staining of the sand, and one contains fragments of what may be tapa cloth. A date on collagen from burial 41 indicates a clearly prehistoric date probably around the beginning of the second millenium A.D. It should be noted that almost all potsherds found in the mound are stratigraphically earlier than burial 41, and by their very eroded appearance would seem to have been in a garden area before becoming sealed under the mound.

The next event on the site was the building of the submound, an oval mound surrounded by a ditch with a gap to the southeast. The mound was formed from spoil won from the surrounding ditch. From the surface of this submound, burials were made in similar pits, but there is no evidence from the excavations of any associated structure on the surface. Evidently some time elapsed after the building of the submound, for the surrounding ditch was almost entirely filled, and a considerable layer of mixed sand

and soil derived from burials built up on the surface. Burials of this period were again in pits with white sand, and a dark stain in the sand is fairly common.

The final stage was the construction of the mound as it is now with spoil from an outer ditch, and further burials in the surface. A collagen C14 date for this period suggests a late prehistoric age. Burials of this period were also in pits with white sand covering, but the dark stain is very rare. Probably even later are several burials in the surroundings of the mound.

ADDITIONAL EXCAVATIONS AT TO-AT-2

Excavations in the area surrounding the mound were made initially in an attempt to locate the source of potsherds found on the surface of the field, and at the base of the mound.

Test pit A was set out on what appeared to be a very slightly raised area southeast of the mound. A series of soil zones was found in this excavation. The surface of the subsoil was not flat, but riddled with small disturbances which may be due to gardening or root action. There were apparently no man-made features. Above the subsoil was a brown soil divided in two by a darker zone in the middle. The total profile was about 30 cm deep. A relatively high concentration of sherds was found in this area, 14 sherds in two square metres. This is relatively low, however, by comparison with sites excavated nearby at Pea and Ha'ateiho. Test pit A can only be characterised as a garden soil containing potsherds.

A series of pits was encountered in Excavation B. These were not all contemporary, but intercutting, suggesting that the area had been used for pits over a period of time. Only the most recent, or the deepest of these pits, survived in recognisable form. In 14.5 m^2, ten pits of recognisable plan were uncovered and there must have been at least four others of which no edges remain in the excavated areas. The pits are of two main forms, circular, and rounded rectangular.

The best preserved (and probably most recent) of the circular pits have pronouncedly undercut sides (Figs. 15-17). The rectangular pits are less well preserved. Two of them, however, seem to have been undercut on one side, but not on the other. Pit G is undercut on the east side, and pit H on the west side. (A number of burial pits also display this asymetric section.)

The floor plans of all the pits are shown in Fig. 15. A, B and C are circular pits with undercut sides of varying diameter and depth. D appears to have been a circular pit of similar type which has been largely cut away. E may be either circular or rounded rectangular and lacks undercut sides. F is probably also an earlier circular pit largely destroyed by later pits.

G and H are definitely rectangular pits, I is probably a rectangular pit, and J is a smaller oval pit with undercut sides.

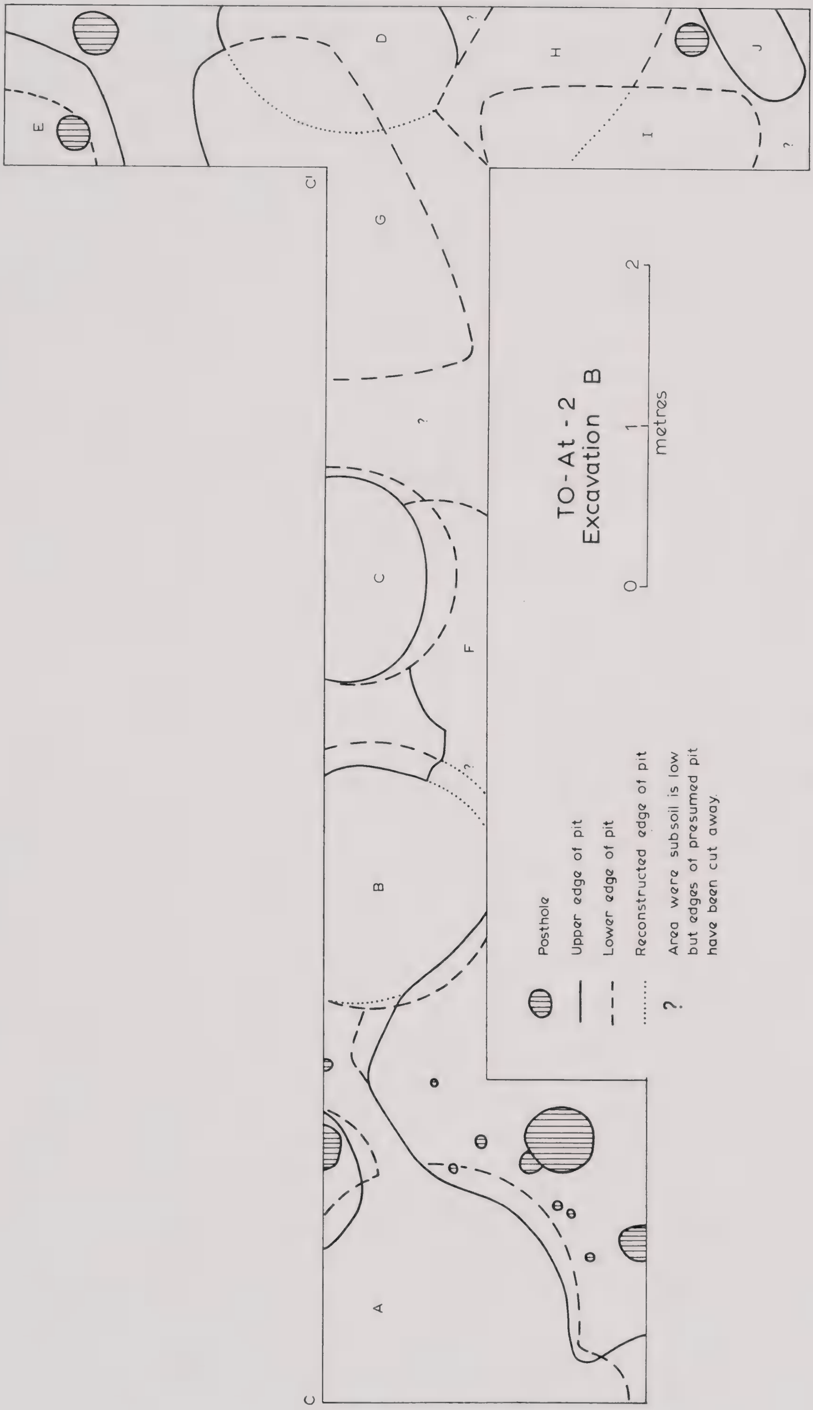

FIG. 15—Plan of pits in Excavation B, To-At-2.

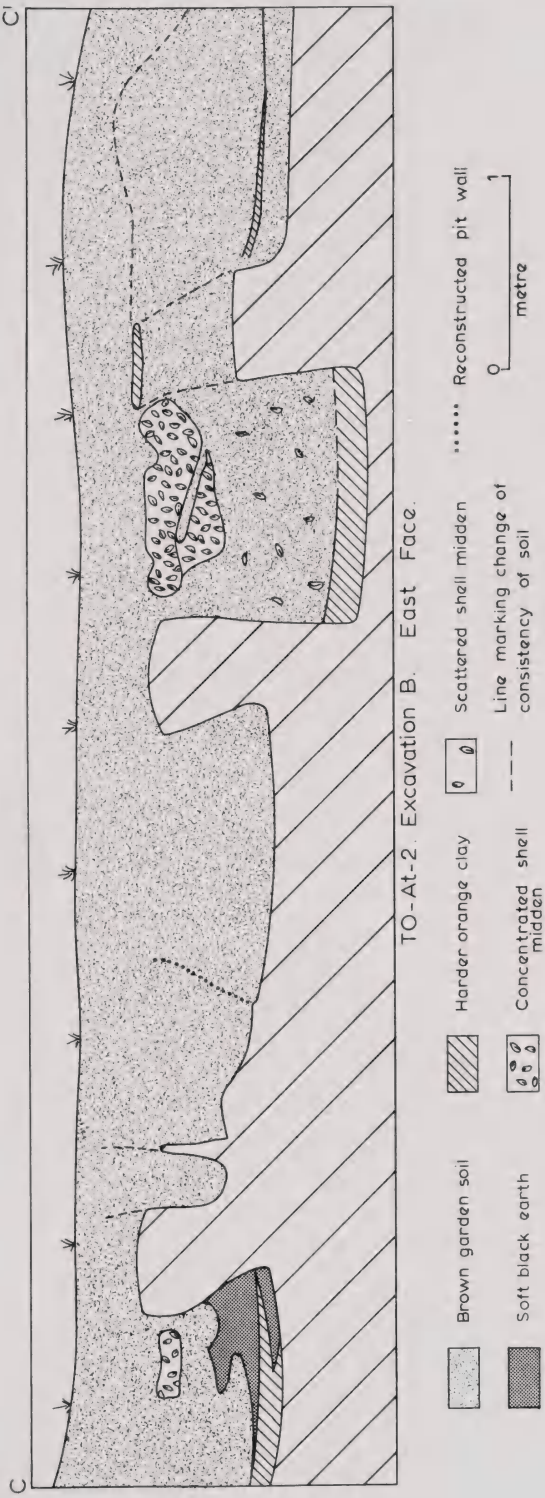

FIG. 16—Section through pits A, B, C, and G, east face of Excavation B.

FIG. 17—Excavation B, To-At-2, showing pits G, C, B and A (from foreground to rear).

Circular pits range in diameter from about 1.2 to 1.8 m, and in depth from 1 to 1.5 m below present ground surface, although the hypothetical pit D would be only 80 cm deep as is E. An interesting feature of pit A is a tunnel or funnel leading from it to another pit of which we uncovered only the edge. The workmen said that this was a feature of pits still in use for ripening bananas.

The dimensions of pit G appear to have been approximately 2 x .5 m. Pit H is of similar size, but whereas G attained a depth of well over 1 m, H was only 80 cm deep. J is the same depth as H, but I is nearer 1 m in depth.

Most of the pits were filled with an undifferentiated brown soil, very similar to the topsoil in the surrounding fields. A and C, however, which seem to be among the most recent of the pits, appear to have filled partly naturally with typical clay lenses near the base and sides, and partly to have been used as dumps for shell midden. By contrast, the earlier pits appear to have been filled deliberately, rather than left open to fill naturally.

The shell midden from these pits consisted largely of *Gafrarium gibbosum* shells. There are occasional other shells, and some burnt coral rock, together with a few fragments of turtle bone and human bone.

Sixteen weathered undecorated body sherds were found in Excavation B. In addition, there were three small pieces of volcanic rock, two of stone suitable for cooking, and one apparently suitable for adze making. Three *Anadara* shells have perforations which would enable them to be used as net sinkers. The potsherds are mostly from the brown soil and, like the sherds in layer 6 under the mound, may have been lying in the area for a long time. The other material comes mainly from the fill of pits A and C.

Extension of Excavation B to the ditch surrounding the mound showed clearly that the Period 4 ditch was stratigraphically later than those pits (D, H, ?) nearest the mound.

On stratigraphic grounds, no more accurate context can be assigned to the pits. The pits themselves appear to relate to a single and continuous phase of activity, possibly several seasons' use of one plantation area, and it is probable that not only D and H, but all pits, antedate Period 4 of the mound. It is unlikely though not impossible that intensive non-funerary activity would be practised in the immediate vicinity of a burial ground. The most attractive context for these pits would be in association with Period 1 of the mound, but although there are some slight inferential grounds for this assignation, stratigraphic evidence to support it is lacking.

It is probable that the pits have some kind of agricultural function. Storage of vegetable crops in pits to ripen or ferment them is widespread in Polynesia, and similar circular pits, sometimes with undercut sides, have been found in excavations in Eastern Polynesia (Suggs 1961, p. 63; Green et al. 1967, pp. 136-137). Pits have also been found in other excavations in Tonga (Birks pers. comm.). The pits in this site have been described in some detail, because their prehistoric context is fairly certain, and their forms are fairly well preserved. It is to be hoped that careful study of historical descriptions, and enquiries about modern agricultural practices in Tonga will produce satisfactory interpretations of these and similar pits.

DISCUSSION

On the basis of these excavations, some conclusions can be advanced concerning burial mounds and burial practices.

The presence of white sand on the surface of a mound, even in small quantities, appears to be a fairly certain indication of a funerary function. On the other hand, the size range reflected in Tonga College mounds (excepting the three at the entrance) does not appear to reflect a difference in function, or in the status of those using the mound. Although To-At-2 is certainly large enough to qualify as a *faitoka* in terms of McKern's description, there is no evidence that it was used by persons of higher rank

than those of To-At-1. The size difference between the two mounds appears to be due to the fact that one is a "three-storeyed" burial mound, while the other has only two storeys.

Excavations in both mounds revealed a continuity in burial practice, apparently over a considerable period of time. In both sites, the characteristic burial pit and partial white sand fill antedate the actual construction of a mound, and the form of the pit and positioning of the individual are similar throughout the use of both mounds. There is no sign in either site of the modern custom of heaping up a mound of white sand over the grave, and no evidence of post-European use in the form of bottle glass decoration.

Evidence is not clear either for the presence of houses on the surfaces of the mounds, or for surrounding fences. This is largely because of the limited area excavated in both sites. At To-At-1 several postholes were found which could relate to one or more house structures on top of the mound. Such houses would have been built after the initial use of the mound's surface for burial, as some Group B burials were disturbed by them. Only one posthole was found in the surface of To-At-2, but this was probably because of the smaller area sampled. This posthole was 60 cm deep and contained charcoal. There is some evidence that fences could have surrounded the mounds, but it is not definite that the postholes are contemporary with use of the mounds.

Although both mounds have similar histories of construction and use, there are minor differences between the two. One consistent difference relates to orientation. At To-At-1, north was the most favoured orientation, with a marked preference for east and southeast at To-At-2. This difference apparently relates to the opening in the surrounding ditch, but this correlation may be purely coincidental, and the difference may merely be a chance preference of two different groups using the mounds.

Another difference is the more intensive use of To-At-1 at both periods of its history. The greater intensity of use tends to correlate with a higher number of immature interments. This may well be due to more selective use of To-At-2 during Periods 2 and 3, than during Period 4, and of To-At-2 at all periods compared with To-At-1, rather than to changes in population structure and mortality rate. On present evidence, it is impossible to say.

A third difference between the two sites is the apparently more restricted use of black tapa at To-At-2, and its more liberal use at To-At-1, which may also be due to slightly differing practices or status of two separate groups. If the dark staining does indicate decayed organic matter, a respectable antiquity for the use of black tapa or mats is indicated.

The age of To-At-1 in relation to To-At-2 has not been determined. Both reflect similar burial practices, and To-At-1 probably falls largely within the time span indicated for To-At-2 by its C14 dates.

McKern's limited excavations in Tonga included four burial sites. One, a site on Pangaimotu, appears to have been similar to the sites described here, although it had subsequently been used for non-funerary purposes (McKern 1929, pp. 104-106). McKern regarded this site as a forgotten *faitoka,* even though it did not contain a coral vault. Of the others, one, with surface stone work, contained an unusual coral vault and limited skeletal remains (pp. 108-109), while two traditional *langi* on Tongatapu lacked vaults, and contained in one case no human remains at all (confirming a tradition respecting its use for the burial of a wooden doll), and in the other only one complete individual and a few disturbed bones (pp. 113-114). McKern noted the constant use of sand in these sites, the presence in the Pangaimotu site of a dark stain in the sand, the general use of the supine position, and varying orientations.

Two burial mounds at least were destroyed during the construction of the airport at Fua'amotu, Tongatapu, in 1940. According to Mr. H. O. Wright, who was engaged in the airport construction, burials in these mounds were covered with white sand, and placed with their feet towards the centre. Children were placed in spaces around the periphery of the mounds (B. I. McFadgen, pers. comm.).

One of Poulsen's sites, To-2, contained a number of skeletons in the upper levels, indicating use of the site as a burial mound. He also encountered an isolated individual buried at To-1 (Poulsen pers. comm.).

McKern's Pangaimotu site, the Fua'amotu mounds, and Poulsen's To-2, all appear to have been similar sites to the two at 'Atele. They indicate widespread use of these sites, lacking coral vaults, but with white sand, and sometimes dark staining of the sand. While orientation within a single mound may be fairly consistent, however, there appears to have been fairly wide variation from site to site.

McKern believed that the coral vault was a fairly late feature of Tongan burial practice, and that earlier burials, even of chiefs, lacked this feature. He thus tended to classify all sizable mounds as *faitoka,* those without vaults being possibly older. It seems likely, however, that the mounds described in this report were burial places of common people, and certainly not burial places of important chiefs.

Considerable evidence is already available about Tongan burial customs and there is undoubtedly a rich field of ethnohistorical material on Tonga awaiting investigation, which will prove of value to both prehistorian and anthropologist. Only most obvious published sources have been consulted to provide a few guidelines for interpreting burial mounds described here.

McKern devoted a considerable part of his field study to a description of burial mounds. He classified all mounds (partly on formal grounds, but largely by the supposed function assigned to them by informants) into *esi* (chiefly resting places), *siaheulupe* (pigeon snaring mounds), and three categories of burial mounds, with a residual category of mounds of unknown use. Burial places were divided into *tanuanga* (commoners' burial

places), *faitoka* (chiefly burial places) and *langi* (burial places of members of the Tui Tonga family) (McKern 1929, pp. 30-31). He realised that this was a functional classification rather than a formal one, but believed that there was a standard recognisable form for each category.

Of *tanuanga* he wrote:

> The *tanuanga* may be described as a small mound of earth or sand, similar in shape and size to European grave mounds. It needs no special consideration as it has no important bearing on Tongan archaeological problems (1929, p. 31).

Of *faitoka*:

> The *faitoka* is normally a comparatively large mound of earth and sand, in shape a truncated cone with moderately sloping sides, containing from one to several stone vaults. The term *faitoka* includes not only the mound, which was more specifically called *foifaitoka,* but also a definite area surrounding the mound where a chieftain's important retainers and distant relatives were buried.

Langi were generally larger and more elaborate, often with dressed stone, and most known *langi* were described individually by McKern. Both *langi* and *faitoka* were believed to contain stone vaults of a similar type. *Faitoka,* of which McKern apparently observed a number, varied considerably in size, but he considered that a *faitoka* of average size would be about 8 feet high with a base diameter of 75 feet (McKern 1929, p. 32), in other words, about the same size as To-At-2.

Present-day informants do not distinguish clearly between the three categories, and it is no longer possible to apply McKern's classification in the field, using traditional evidence.

Various early visitors to Tonga described burial mounds of important personages, usually referred to as *faitoka,* and several are illustrated. The word *langi* is not mentioned in early accounts. Cook described a large "Affi-a-too-ca or burying ground belonging to the King", although he subsequently used *morai* interchangeably for *faitoka,* and implied that such places were used for religious purposes as well as for burial. He may have been influenced by Omai's interpretation of Tongan custom. The *faitoka* he described consisted of three mounds surrounded by a stone wall. Each mound was surmounted by a house, and Cook was told that the dead were buried in a stone vault beneath the floor of the house (Cook 1967, 1:138). He did not observe a funeral. A "fyatocka" or "fiatooka, or morai", with four small houses on its surface, was drawn by J. Webber, and another larger mound with a house on its surface, in another of Webber's illustrations, may also be a *faitoka* (Cook 1784, Atlas pl. 21-22).

The missionaries left in Tonga by the "Duff" in 1797 also described several "fiatooka". They first visited the "fiatooka" belonging to Mumu'i, which they described as a beautiful, solitary place surrounded by trees, containing two god houses, one apparently concerned with male pursuits such as war, and one with female affairs, notably bark cloth manufacture. There was no mention of burial (Wilson 1799, p. 235). A later description, however, referred to a mound some 7 feet high and 120 yards in circumference, with a house on top, beneath the middle of which was a coral vault (p. 241). Here they saw a funeral and described quantities of black tapa being lowered into the grave.

Two *faitoka* each containing three tombs were seen at Togamalolo, forming part of a complex together with a large house and an open green space (p. 252); and the burial mounds at Mu'a, now usually called *langi*, were described as "fiatooka" and said to be badly overgrown and in disrepair at that time (Wilson pp. 252, 283-285, and print).

Mariner also observed funerals. He defined "fytoca" as:

> A burying place including the grave, the mount in which it is sunk, and a sort of shed over it. The grave of a chief's family is a vault, lined at the bottom with one large stone, one at each side, and one at the foot and head . . . covered at the top with one large stone (Martin 1827, 1:135).

By the time Dumont D'Urville reached Tonga, contact with Europeans was well established. The illustrations of his first voyage include three views of chiefs' burial mounds, and a plan of some of the sites at Mu'a (Dumont D'Urville 1833, Atlas pl. 80, 86, 95 and 101). At least one of the mounds illustrated is no larger than To-At-2. All have one house on them.

These brief examples from historical descriptions suggest that during the early European period *faitoka* was the widely used term for a burial place, particularly that of a chief. Most, if not all of these chiefs' burial places were said to contain a coral vault, and all had at least one house on them. Webber's drawing with its several small houses perched at precarious angles on the slope of the mound is exceptional.

To-At-2 appears to be within the size range of these *faitoka*, particularly those illustrated by Sainson, the artist with D'Urville. In its lack of a coral vault, however, it falls short of the description of chiefs' mounds, and it seems reasonable to assume that this site, like To-At-1 was probably not a chief's burial place.

Little can be said about the groups using the mounds. Again, historical research may produce evidence about Tongan social structure which would provide a clue as to the identity of the groups likely to be responsible for raising and using mounds of this type. The apparent evidence for continuity of burial practice at each site suggests that each was used by members of one social group who were acquainted with the practices relating to each mound. Some account of the population as represented by skeletal remains in the mounds is given in the following report. A few comments about the appearance of the Tongan people as observed by early visitors to Tonga may be appropriate here.

Most visitors from Tasman on commented on the robust stature of both men and women. Of particular interest, in view of the various evidences of pathology observed in the excavated skeletons, are comments about disease.

Cook noted the presence of venereal diseases, reported by his crew, on his third voyage (1777). He and his crew were convinced that these had not been present at the time of his earlier visits (1773, 1774) and apparently Tongan informants upheld this view. Cook also noted that from the time of his first visit many Tongans had been afflicted with ulcerous

sores similar to those resulting from venereal disease, but said by the Tongans to have been present before European contact, and to be due to different causes (Cook 1967, 1:170-171).

Mariner, on the other hand, believed that venereal diseases were not present in Tonga during the first decade of the 19th century, though he commented on various ulcerous afflictions (Martin 1827, appendix 2) as did the first missionaries (Wilson 1799, p. 264). Mariner also commented on the skill of the Tongans in setting fractures (Martin, appendix 2).

There is abundant evidence for the existence of ulcerous infections of a kind which could be responsible for the observed pathology of a number of bones excavated. The more precise diagnosis of this disease, however, is dependent on whether syphilis was present in pre-European times. Historical evidence suggests that it was not.

The position of the 'Atele mounds in relation to other sites is of interest. As stated above, the majority of visible mounds in the college grounds are burial mounds, and there is a conspicuous lack of large mounds of unknown function such as abound in some areas of Tongatapu. No occupation site of any depth or concentration has been located at 'Atele, although such sites abound at Pea and Ha'ateiho.

The absence of occupation sites suggests that the 'Atele area has never been used on a large scale for settlement, but that it has served as an agricultural area, and for burial of people from neighbouring settlements. Such an explanation would help to account for the conspicuous lack of pottery throughout the area. If pottery was made and used widely throughout the prehistoric period, more would have been found at 'Atele than has so far been located. An alternative explanation would be that pottery was not made or used at 'Atele during the period the burial mounds were in use. In this case the absence of pottery at 'Atele would not necessarily imply an absence of settlement. However, such a view is entirely inconsistent with the results of excavations at Pea by Poulsen, and cannot be seriously entertained at this point.

The other explanation, that 'Atele was not a residential area, opens up interesting possibilities. The nature of sites at 'Atele contrasts markedly with the situation at Pea and Ha'ateiho, and suggests that population has been clustered in these latter areas for a long time. It is widely accepted that settlement in Tonga was not nucleated prior to the civil wars of the protohistoric period. This may well be true on smaller islands. In Tongatapu, however, the evidence from Pea, Ha'ateiho, and 'Atele, suggests a marked and continuous preference for the two former over the latter as a residential area, and a use of 'Atele for non-residential purposes such as cultivation, and burial.

CONCLUSIONS

Investigation of these two small burial mounds has revealed that even very small mounds were used intensively for burial over a long period

of time. Both mounds show successive stages of use for burial, two at To-At-1 and three at To-At-2. In both cases the first stage antedated the construction of the mound, although burial in an extended position in pits with white sand covering was the rule in both sites throughout their use. To-At-2 is larger than To-At-1, not because it is a different kind of site, but because it went through a third stage of use, while To-At-1 had only two.

Both mounds are estimated to contain well over 100 individuals, with To-At-1 probably containing more immature individuals.

Some evidence for initial non-funerary use was encountered at both sites, but neither at these two sites, nor elsewhere in the 'Atele area, was evidence of habitation of any duration noted. There appears to be a strong contrast between 'Atele and neighbouring Pea and Ha'ateiho, suggesting a possible long standing concentration of residence at the latter areas, and a use of 'Atele for burial and agriculture. Numerous pits on the edge to To-At-2, and faint signs of human activity in the early periods of both sites, are assumed to be evidence of cultivation and food storage.

McKern's threefold classification of Tongan burial sites is found to be unsatisfactory, both for present-day use, and in terms of early European descriptions of Tongan burial practices. Such descriptions are largely confined to chiefly burial places, several of which were illustrated, and appeared to differ little from To-At-2, except in size, most being larger. All had houses on the top, and some evidence for surface structures was found in both To-At-1 and To-At-2. The principal differences between To-At-2 and these *faitoka,* or chiefly burial places, is the absence in the former of a coral vault, and perhaps its large number of burials.

There would thus appear to be no universal rule for distinguishing in the field between the larger of the commoners' burial places and the smaller chiefly mounds. The gradation and overlapping of mound size may reflect a gradation and overlapping of status. Burial customs observed for chiefs in the early European period were probably imitated on a lesser scale by all classes of Tongan society at that time. The main elements of these burial customs appear to extend back at least to the beginning of the present millenium.

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AN OSTEOLOGICAL STUDY OF CRANIAL AND INFRACRANIAL REMAINS FROM TONGA

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Abstract. Individual burials recovered by archaeological excavation from two prehistoric Tongan burial mounds are described. Remains (often incomplete) of some 99 individuals are analysed where possible according to age and sex and an assessment of stature and build attempted. Morphological and some metrical data for both cranial and infracranial material, and nonmetrical data on dentition are presented. A section on palaeopathology is included. Limited comparisons are drawn between the excavated sample and modern (c. 1920) Tongans.

1.1.

The report that follows is an osteological (odontological) analysis of cranial and infracranial remains from two Polynesian burial mounds (To-At-1 and To-At-2) excavated by J. M. Davidson in 1964 on the island of Tongatapu (Davidson, this volume). This study was carried out during a six-week period from July 1967 to mid-August at the Auckland Institute and Museum in Auckland, New Zealand. It constituted part of a summer's independent fieldwork programme for purposes of collecting data to be used in my doctoral dissertation in Physical Anthropology at the University of Toronto.

1.2. Acknowledgements

I wish to acknowledge the assistance of Miss Janet Davidson and others at the Auckland Institute and Museum in Auckland, New Zealand, for making available for study the skeletal collection here to be described. My thanks are also due to Miss Davidson for supplying me with information regarding her archaeological excavations and exhumation of these bones.

Also, I am indebted to the Department of Anthropology, University of Auckland's photographer, Mr. Cyril Schollum, who did much of the photographic work here presented, as well to Mr. John Glover for assistance and fine work at the University of Toronto.

My stay in Auckland was enhanced by introduction to and conversation with resident anthropologists, students and other interested persons, making the time spent there much more enjoyable and profitable.

Facilities and university personnel at the Universities of Toronto and McMaster in Canada are here acknowledged as being most important in

* This paper was prepared while the author was a graduate student in the Department of Anthropology, University of Toronto.

the initiation of the project and carrying out of the analysis and writing of the manuscript on return.

Special thanks for reading the manuscript are here given to Miss Lindsay Niemann, Professor B. Yamaguchi, my supervisor, and Professors D. R. Hughes and J. E. Anderson, all of the University of Toronto.

1.3. Importance of Study and Problem Orientation

In view of the parlous state of physical anthropology in Polynesia today, a skeletal collection of such size, condition and certified provenance has significant implications for all branches of anthropology.

1. The amount of skeletal material from Western Polynesia now available for research in museum and private collections is negligible. Furthermore, the usefulness of such examples as are extant is usually vitiated by lack of archaeological control which might provide temporal or spatial relationships. This new material adds appreciably to preexisting samples and, in some respects, is the sole representation of a prehistoric Tongan people. In comparison with other individual collections, this bone assemblage far exceeds any other known. In fact, its size exceeds that of all other collections put together.

2. As most other existing collections are composed almost entirely of crania and mandibles, the infracranial material now present is a most welcome addition and although fragmentary at times, exceeds both quantitatively and qualitatively other comparable holdings. Analyses of infracranial remains of any population are few and this appears to be the first for Tonga or Western Polynesia.

3. The exhumation of this material was carried out under controlled archaeological procedures.

4. At least two reliable radio carbon dates indicate that these remains represent a pre-contact people so that the presence of effects due to miscegenation may be excluded.

Although a site report and description is the primary objective, there is still a large spectrum of personal interpretation as to what a site report should and can include. The avenues of approach are numerous and the methods of analysis varied. As an anthropologist and not a human anatomist, epidemologist, human geneticist, orthopaedic surgeon, biochemist, pathologist, or any other specialized researcher *per se,* I hope, at least to touch on as many aspects of a pure osteological analysis as possible. Speaking more generally, I would like the report to serve as an integrative matrix for the physical description and its environmental domain. Nonmetrical findings will be stressed over the traditional caliper approach with emphasis on discontinuous morphology. In most instances, trait variation, dimensional differences, and palaeopathological data are compared on the basis of sexual differentiation. In some cases, however, the data will be presented on a mound basis. The reasons for presenting comparisons on a mound-association foundation is because of the uncertainty of the temporal

association of the two mound groups and also the appropriateness of comparing samples by the discrete-trait method on either a time, as in this case, or on a spatial alignment. Even though individual sample sizes are small and therefore the statistical implications somewhat tentative, for presentation purposes, a morphological analysis seems more important. The data to be presented here will at least provide a basis to which the remaining unexcavated material of these two mounds might be added hopefully at a future date.

More specifically, the report will include brief descriptive notes on the individual burials, a summary of age and sex proportions and their demographic purport, a metrical and morphological analysis of the skull and infracranial skeleton, dental findings, a descriptive section on palaeopathology and, finally, comparisons.

1.4. Methods

The skeletal remains were studied by one person and observations for each individual were recorded separately on a number of forms representing various regions of the skeleton. Reconstruction of fragmented material was undertaken in many instances before any observations were possible. The unscrambling of 'mixed' individuals and orientation in a supine position were standard preparatory procedures.

All metrical data and tests of significance were analysed by use of an Olivetti table-top computer and all non-metrical data were quantified by entry onto IBM punch cards and then sorted and the incidences computed by using an electronic calculator.

Definition of measurements as used in the study are to be found prefacing Appendix 1 and 2 for cranial and infracranial osteometry.

AGING

Spheno-occipital synchrondorsis and epiphysis-diaphysis fusions were the most important criteria in distinguishing adult-subadult skeletal remains and also in determining a more specific age assignment of the immature individuals. Ossification of cartilaginous precursory matrices as in the wrist and knee region of the subadults was also of major importance when individual burials were complete.

Of the skull, fontanelle and sutural closure and tooth eruption were valuable guidelines in determining the relative age of the individuals under consideration.

The symphysis pubis was often not able to be studied, the frequent damaging of this area made a more specific chronological assessment impossible for the adult sample. For this reason, only a 'young', 'middle-aged', and an 'aged' classification was possible. Dental deterioration and other degenerative skeletal signs were also useful in assigning individuals to these relative age categories (Krogman 1962, pp. 18-111).

SEXING

Sexing of the subadult skeletal material was not attempted. Of the adult series cranial, pelvic, dimensional aspects of articular surfaces and lengths of long bones, and general robustness of the skeletal remains were the essential discriminating techniques employed (Krogman 1962, pp. 112-152).

In many instances it was not possible to determine sex because of paucity of the remains or because of the destruction of these vital areas. If discrepancies among the discriminating techniques were found for individual cases it was usual to grant more weight to pelvic indicators.

OTHER

A few specimens of bones showing pathology were brought back for further study consisting of X-ray, photography, and transverse sectioning. The results of these further investigations will be discussed in the chapter on palaeopathology.

1.5. Descriptions of the Individual Burials from Tonga College ('Atele) Mounds

This section will contain a summary of the salient features of the individual burials presented in accordance with the appropriate mound association and catalogue designation. Observations most commonly noted are those concerning probable sex and age assignment; parts of the skeleton present; and any obvious bone pathology or trauma. Age estimation is designated (S.) when criteria from the skull were used; (D.) when the tooth eruption sequence was employed; (I.) when infracranial (usually long) bones form the basis; and (V.) when the decision was based on the degree of ossification of the vertebral components.

The slight discrepancies that may be noticed between my catalogue's assignment and those found in the archaeological notes of the site may be attributed to (1) overlapping of the burials *in situ,* (2) scrambling of individuals post-excavation, (3) fossicking, and (4) the existence of a catch-all category containing miscellaneous and uncatalogued remains.

To-At-1

1-A. The skeletal remains suggest that this individual was approximately three years old (D., V.). The skull is preserved in a moderately fragmentary state, but infracranially only the vertebral column, ribs, and upper limb bones are present. Because of the fragmentary condition, measurement of the long bones present was not possible.

1-B. An infant about nine months old (V., D.). The cranial elements are well represented, but are mostly disarticulated. A few fragmented infracranial bones are present from the left side, but there are none represented post-femorally. The innominate bones and femur appeared to be charred.

2. A child of roughly two to three years of age (based on comparative lengths of long bone) represented by only a few infracranial bones, some

of which were measurable while others were not owing to damage at their proximal and distal extremities.

3. Another subadult individual of approximately two years of age (S., V., D.) with most of the major bones of the skull represented but fragmented and disarticulated although the mandible is fairly complete. The infracranial skeleton is represented but the long bones were not measurable.

4-A. An adult female whose cranial fragments have been reconstructed, resulting in several large components of the skull. The mandible was also fragmentary but morphological observations for it as well as the cranium were noted. No infracranial bones were present nor pathology of bone. The external surfaces of these skeletal remains displayed a characteristically chalk-like appearance owing to preparation procedures (washing and scrubbing) later noted for certain other individual remains.

4-B. An adult of unknown sex represented by a few long bone fragments all in a highly pathological state. With the exception of one fragment of a femur, all the bones present are from the upper appendicular skeleton. Pathology of this individual and others will be dealt with more thoroughly in a later section.

4-C. The skeletal remains carrying this designation are representative of at least one child and one small adult. The child was aged between two and seven years of age, there being only infracranial representation on which to base age estimation.

5. New born to six months of age (I., D., S.) was assigned as the skeletal age of this individual. The skull was very fragmentary and a mandible fragment and a few separate tooth buds were present. All the major long bones were represented and measurements taken.

6. A middle-aged male whose skeletal remains were quite complete except for minor losses in the hand and foot regions. Some unassociated hand and foot bones were segregated. The remains are suggestive of a very robust-looking individual. Some pecularities of the supraorbital and nasal regions were noted along with excessive periodontal disease. Arthritic changes of the long bones were scored from light to moderate degrees and several specimens of calcified blood vessels were distinguished.

7. An aged male represented quite well cranially and infracranially with some intrusion and omission in the hand and foot regions. The dentition was carious (interproximal neck caries) and osteoarthritis of long bone was graded as occurring from light to moderate in degree of severity.

8. An age assignment of six months or less was given to this individual. The skull was in a very fragmentary condition whereas the mandible was represented by only a fragment from its anterior region. A few separate anterior teeth and deciduous tooth buds were also present.

9. An adult (not old) male represented cranially by a partially reconstructed skull and complete mandible with intact maxillary and mandibular dentitions. Infracranially the presacral vertebrae were well represented

and extreme lipping, fusion, and arthritic involvement were noted in the thoracic region. The remaining infracranial skeleton was well represented except for a few major bones of the lower limb and hand and foot bones. Osteoarthritis, where studiable on the long bones, was not extreme.

10. Three individuals are represented under this catalogue number. An adult (not old) male was the major individual well represented by its vertebral column, mandible (labelled B10) and partially reconstructed skull and a few long bones of robust dimensions. Other skeletal remains labelled '1-10' were representative of a smaller adult (probably '1-11') and those belonging to a child.

11. An adult female represented by seven skull fragments, a mandible and left maxilla both with intact dentitions. A few fragmentary infracranial remains from all regions also were present for this individual.

12. An adult male whose skull lacks maxillae. Also present are mandible and a few separate maxillary teeth and many small cranial and infracranial fragments. Postcranially, vertebrae and major limb bones are present. The carpal bones show extensive osteoarthritis and the left ulna displays a healed fracture. A depression on the left parietal bone is also noteworthy.

13. An adult female having only six cranial fragments from the parietal and sphenoid components representing the skull. Many small fragments of long bone representing only a minor portion of a whole skeleton were attributed to this individual.

13-C. An adult of unknown sex represented by tarsal and metatarsal fragments was given this designation to correct its supposed association with '13' proper. These bones do not appear to belong to either individual '9' or '4' which appear stratigraphically close to '13'.

14. An adolescent of approximately fifteen years of age (D.) represented by a few cranial fragments, mandible, and maxillae fragments. Rib, vertebral and upper limb fragments were also present.

16. Newborn to six months old (possibly foetal). Tympanic development was probably in stage II (Anderson 1962a, p. 145) and the cranium was in several separate pieces. Long bones, of which some were measurable, also were particular to this individual.

17. Another infant between 0-8 months of age (older than '16') characterized as having a fragmented and incomplete skull and associated mandible and maxillae fragments. Vertebrae, ribs, and upper limb bones also were present but not completely.

18. Approximately two years of age and represented by maxillary and mandibular fragments (almost complete) and some separate deciduous teeth.

19. An adult (not aged) of unknown sex. The cranium was partially reconstructed to give a calotte with petrous part of the temporal bone plus occipital bone in addition to separate bones and fragments. Infracranial

representation was quite good except for frequent damaging of the extremities of the long bones.

19*. This 'unplaced' individual is represented by an intact cranium and first cervical vertebra.

20. An adult male (not old) of fairly robust build. The skull was in a fragmentary condition; mandible and both dentition complete. The infracranial remains include only vertebrae and fragments of vertebrae.

21-A. An adult of unknown sex represented by a highly pathological and reconstructed calvaria, right maxilla and fragments of upper limb bones. The left ulna is illustrative of a kind of pathological involvement typical of most of the surface lesions found not infrequently for this skeletal collection (see palaeopathology section).

21-B. Adult of unknown sex represented by fragments of a humerus and several lower limb bones of which the tibiae display typical pathological lesions.

22. An adolescent of roughly twenty years of age represented by a very fragmented skull. Infracranially, this individual is represented by vertebral fragments, long bones which are missing proximal and distal extremities owing to damage, and bones of the right and left feet.

23. A young female known from a partially reconstructed cranium, mandible, and complete dentitions. The presacral vertebrae are well represented but the long bones are greatly damaged.

25. A child of approximately three years of age represented by a mandibular fragment with intact deciduous teeth and a few fragmented bones of the upper limbs only.

26. A fragmented cranium, associated mandible, infracranial bones superior to the thoracic region are representative of this adult female. Decomposition of these bones was excessive and was probably due to soil acidity.

27. Apparently an adult male represented by a highly fragmented infracranial skeleton which included only a few fragments of vertebrae. The bones were greatly rarefied and fragile.

28. A child of approximately eight years of age (V., D., I.) possessing an incomplete and highly piecemeal cranium, complete mandible, and an incomplete and fragmented infracranial skeleton.

29-A. Only a few fragments are representative of the cranium of this individual and two mandibles were found with this catalogue designation. The infracranial remains are those of a robust, adult male. The left tibia is swollen and pathological.

29-B. A child, three years of age (V., D., S.), represented by mandibular, maxillary, and other skull fragments. Infracranially, this individual is represented by numerous long bones which were quite damaged.

29-C. New born to six months of age (V., D.). The cranium of this individual was highly fragmentary and the mandible was represented by

only a small piece from the left side. Although damaged, the infracranial representation was quite good.

30. Only maxillae (with intact dentition) and zygomata represent this subadult Tongan whose age is placed at about thirteen years. The infracranial skeleton is represented by fragments of a clavicle and scapula.

31. This adult male is represented by only a few infracranial bones mostly from the lower limb region.

32. An age of new born to nine months is assigned to this individual, poorly represented by only skull fragments and a left humerus.

33. No specific age assignment was given to this individual except to say that it was a child, represented by only one right parietal fragment and four or five small cranial fragments. These remains may very well belong to individual '2' as might be verified by stratigraphic positioning and relationship.

34. The skeletal remains of this young adult male are in an excellent state of preservation infracranially having a reddish tinge to them. The cranium was fragmented and complete and the vertebrae were well represented, but only the left side of the appendicular skeleton was available for study.

35. An infant of approximately six months age (D., V., S., I.), well represented cranially and infracranially.

36. A two-year-old (D.) with skull well represented but disarticulated.

37. Only one cranial fragment of the right parietal bone represents this child of seven or eight years of age. The infracranial skeleton is well represented although damaged.

38. An infant assigned an age of nine months.

To-At-2

1-A. The skeletal remains are those of a child three years of age with most of the bones of the cranium present, but disarticulated, and associated mandible and complete dentition. Most of the long bones are present with the notable exception of the left femur, tibiae and foot bones.

1-C. A small female of middle- fringing on old-age with most of the facial and anterior basal elements of its skull missing. Mandible and complete dentition are present with the maxillary teeth showing marked caries. The infracranial skeleton is missing all bones inferior to the pelvic region. The right radius and ulna show distinct evidence (external) of a poorly healed fracture.

1-D. The metacarpal epiphyses of this individual have just fused to their diaphyses whereas the condylar epiphyses of tibia and a femur are still separate. In all, this adolescent of approximately sixteen years of age is represented by a right fifth metacarpal, tibiae, fibulae, and femur fragments.

1-E. At least four individuals are designated '1-E'

(1) A child of three to four years of age is represented by a fragment of the left mandibular half and left maxillae both with intact deciduous dentition.

(2) The right and left maxillae and complete mandible are representative of an adult male.

(3) A small adult is represented by complete maxillae.

(4) An adolescent (seventeen to eighteen years of age) was sorted out as having a complete vertebral column, highly fragmented scapulae, humeri, innominate bones, manubrium, and sternebrae elements particular to its skeleton.

2. This infant possessed an unfused metopic suture and was assigned an age between new born and six months (V., S.). A fragmentary and incomplete cranium and damaged right mandibular half characterize the skull. Measurement of the major long bones was possible.

3. A child of approximately six years of age with cranial elements well represented but disarticulated and somewhat fragmented. A damaged mandible and maxillae with deciduous dentition were also present. Infracranially, this skeleton was represented by only a few rib fragments and by its first cervical vertebra.

4. The skull of this very tall and robust individual was not available for study and its very complete infracranial remains are thought to represent a person of middle-age characterized as a female primarily on the basis of pelvic conformation. A congenital absence of a thoracic vertebra (first) is certain as well as a fracture in the distal third of the right ulna in addition to pathology of the sternal extremities of the first ribs which will be noted further later.

5. This individual is tentatively assigned as an adult male and is especially notable in having its right and left foot bones (along with numerous sesamoid bones) well represented and fibular fragments, which are pathological, present.

6. A fairly robust, young male with cranium and mandible in a fragmentary but reconstructable condition. The infracranial remains are scanty; there being only a few bones of the shoulder girdle and thoracic regions present along with some bones from a right hand.

7. With the exception of hand and foot bones, the remains of this child between the ages of one and two years (V., D., S., I.) are complete and in excellent condition.

8. The bony remains comprising tibiae, talar and metatarsal bones are probably those of a robust adult male.

9. The skull and upper infracranial skeleton of this two-year-old (V., D., I.) are fairly complete.

10. All bones of this individual are from the lower limb regions comprising a highly fragmentary and incomplete assemblage of this adult of unknown sex.

11. An adult (23 years of age) female with complete skull missing only facial elements and infracranially well represented down to and including the femora.

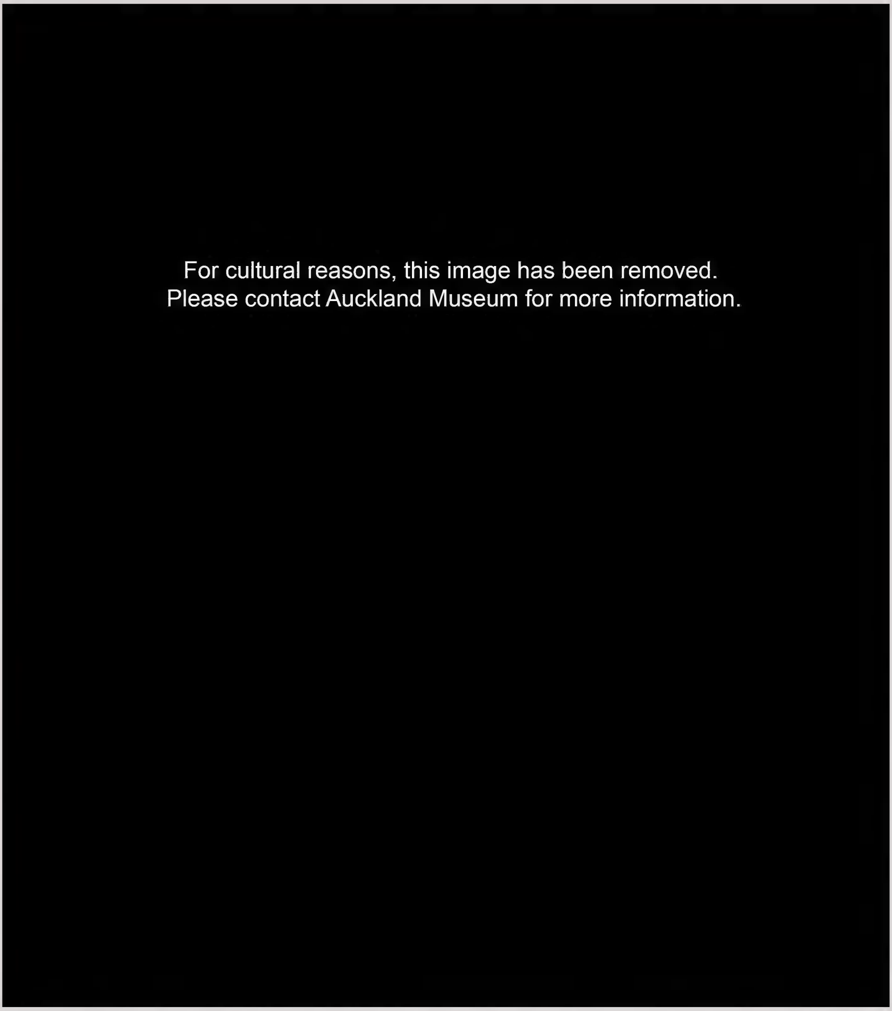

FIG. 1—A lateral view of the skull of To-At-2-13, a middle-aged male.

13. A complete skull (Figs. 1-3) and long bones from the upper limbs are all that remain of this middle-aged male. Slight osteoporosis of the supraorbital region and some other pathological disorders of the skull were observed as well as extreme osteoarthritic lipping and erosion in the cervical vertebrae.

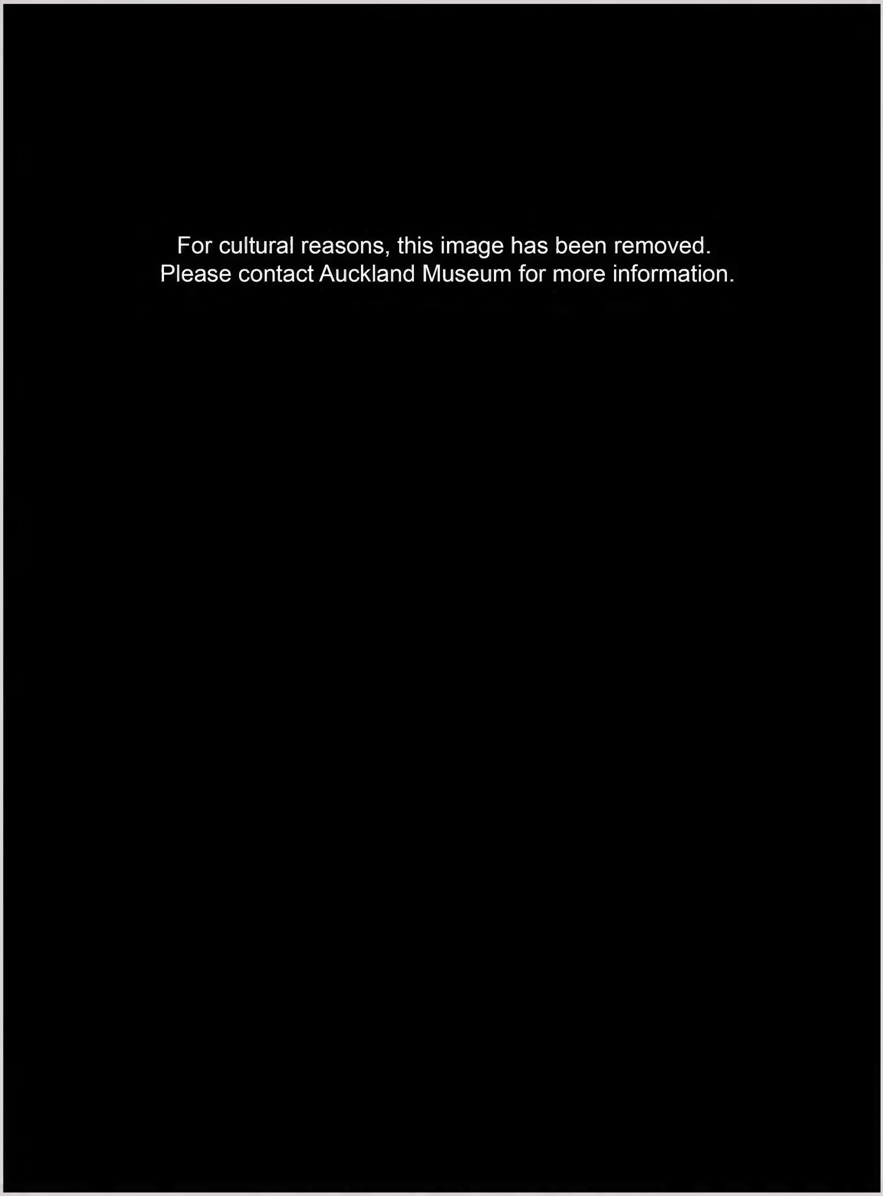

Fig. 2—Frontal aspect of To-At-2-13's skull.

13-A. This individual was very similar to '13' in general morphology being also a robust middle-aged male with complete skull and the infra-cranial skeleton fairly complete to about the ninth thoracic vertebra.

13-C. An adult (fairly robust) male represented by femora shaft fragments and one tibia mid-shaft fragment.

14. An age of new born to one year (V., D.) has been ascribed to this nearly complete infant skeleton.

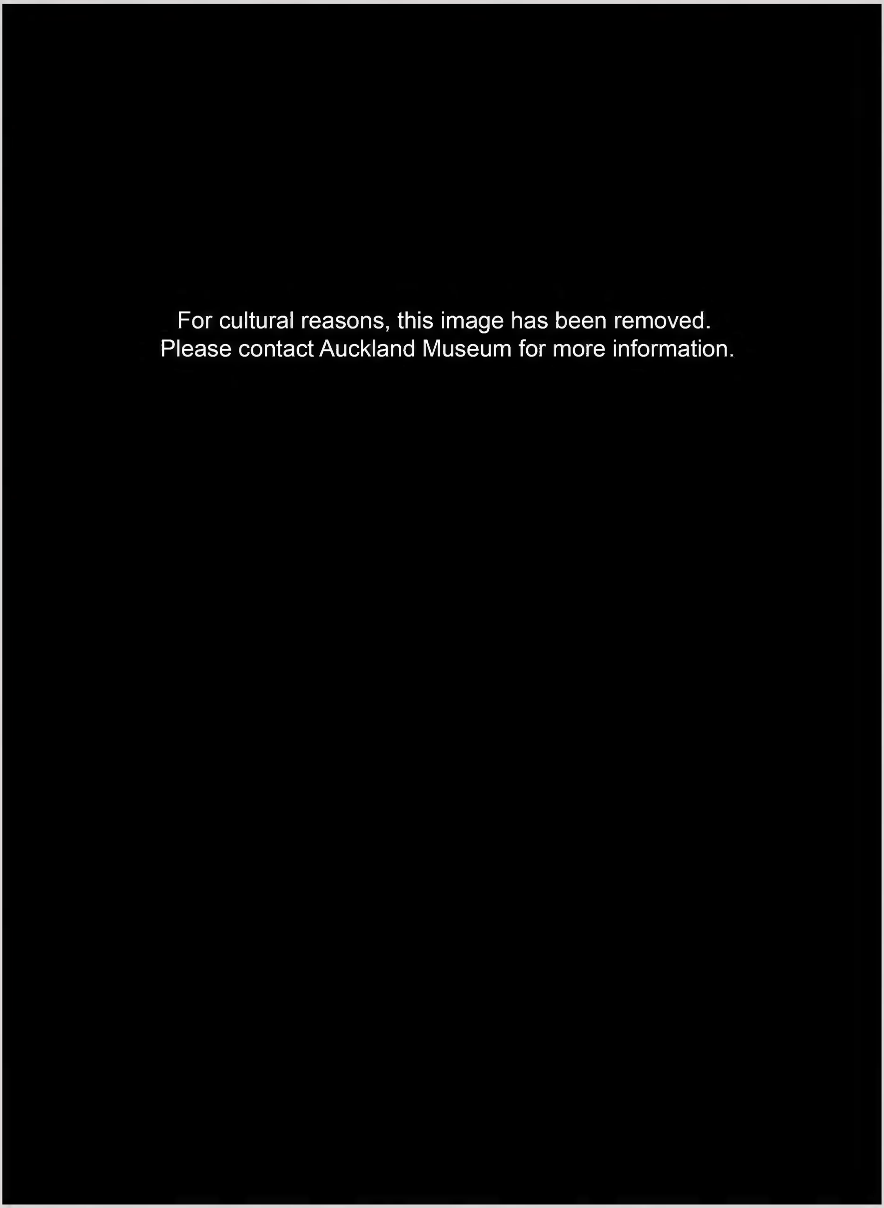

FIG. 3—Posterior view of To-At-2-13's skull.

15. A 15-year-old adolescent (metatarsal epiphyses still unfused) represented only by tibial fragments and pedal bones.

16. Only a fragmented mandible is present for this young adult female infracranially represented by the upper limb skeleton.

17. This infant (new born to two years of age) is well represented infracranially but there are no cranial bones available for study.

18. The bones of this old adult male are generally arthritic. Of the skull, only a reconstructed calvaria and fairly complete mandible remain. In the teeth present caries are prevalent, and two proximal phalanges of the right hand show possible healed fractures.

19. A male (twenty-two to twenty-three years) represented only in the pelvic and lower limb region (lacking pedal bones) except for the inclusion of a few bones from the right hand.

19*. No catalogue number was given to this nearly complete cranium which is believed to be an adult (not old) male and possibly belonging to '19'.

20. The lower limb bones are all that remain of this adult female. Two intrusive femoral shaft fragments were also noted.

21. Another adult female represented also by only the lower limb skeleton.

21-B. A child of approximately five years of age (V., I.) is here represented by innominates, femur, vertebrae, ribs, and hand bones.

22. The robustness of the skeletal remains of this individual lend credence to its assignment as an adult male. Only skeletal remains from the lower appendicular and left hand are present.

22-A. Another adult male (slightly less robust than '22') infracranially represented by the lower limb (tibiae, fibulae, and foot) skeleton.

23. Bones and fragments of the lower limb skeleton are all that were available for study of this adult of unknown sex.

24-A. A small adult female characterized as having a fragmented and incomplete skull. Best representation of the bones of the infracranial skeleton was in the vertebrae.

24-B. Another small adult (middle-aged) female much like '24-A' in its incomplete skeleton.

25. The skull of this adult (not old) female consists of two major reconstructed pieces and a few separate cranial fragments and complete dentition. The vertebral column is in excellent condition and present from the first cervical to the tenth thoracic vertebra inclusive. Humeral, scapular and clavicular fragments are also present.

26. An adult female of which no cranial or mandibular bones are present. Bones of the infracranial skeleton are incomplete, but in an excellent state of preservation.

27. Two mandibles are assigned this catalogue number; one fragmented and the other complete, as well as a broken and incomplete cranium. Infracranially, this adult female is represented by bones of its appendages and vertebrae.

27-A. This adult female is not associated with '27' as cataloguing suggests, and is represented by infracranial bones only.

28. An adult female fragmented skull with only the mandibular dentition present. These remains may belong to '29' which was not located as described in the archaeological field notes.

30. No cranium but two mandibles (one complete and the other only a fragment of a left mandibular half) were found to denote this adult female sporadically represented by various bones and fragments of the infracranial skeleton. Some intrusion and mixture with another individual as well as fragments of non-human bone were also found.

31. A reconstructed and incomplete calvaria and associated mandible and some infracranial bones represent this young adult male. Of particular note is the presence of an *os inca.*

32. The cranium of this adult female is represented by only a few bony fragments and a complete dentition. All upper and lower limb bones are greatly broken and soil-eroded.

33. This young adult male has skeletal remains comprising a reconstructed calvaria, mandible, and a fragmentary and incomplete infracranial skeleton.

34. An adult of unknown sex, having tibiae, fibulae and femoral fragments in addition to talar and metatarsal bones available for study.

35. Another adult of unknown sex, represented by bones and fragments of the lower limb skeleton only.

36. Mandible and maxillae denoting a child of approximately four years of age (D.).

37. Fragmented pedal bones and fragments of the left tibia and fibula were appraised as those of an adult of unknown sex.

38. Fairly complete left and right foot assemblages (no phalanges) and one left fibula missing its proximal portion comprise this adult (male?) individual.

39. This juvenile of less than fourteen years of age is represented only by pedal bones; the metatarsal and phalangeal epiphyses are as yet unfused.

40-A. An old adult female is here represented by a reconstructed and incomplete calvaria, complete mandible and an infracranial skeleton composed of the upper limb and upper axial regions.

40-B. The mandible and maxillae with fairly complete dentition of an adult of undetermined sex.

41. A partially reconstructed skull, edentulous (premortem) mandibular and maxillary fragments, and an incomplete and fragmentary infracranial skeleton denote this individual as an old adult male. Also found in this particular bone assemblage were fragments of long bones of a very small adult or an adolescent and some non-human skeletal remains (turtle?).

42. An adult male found to have a mandible and separate maxillary teeth, and infracranial representation down to the mid-femoral region. All the bones, with the exception of the humeri, were quite fragmented.

Miscellaneous skeletal remains studied

The entries listed here are all uncatalogued and it was not possible to decide to which of the above individuals and/or other individuals they should be assigned.

CRANIAL

Assigned Cataloguing	Description	Sex	Age (Adult)
MS1	Skull	Male	Old
MS3	Skull	Female	Old
MS4	Skull	Female	? (not old)
MS5	Skull	Female	Old
MM1	Mandible	?	?
MM2	Mandible	?	?
MM3	Mandible and Maxillae	Male	?
MM4	Mandible and Maxillae	?	?
MM5	Mandible and Maxillae	Female	?
MA1	Maxillae	?	?
MA2	Maxillae	?	?
MA3	Maxillae	?	?
MA4	Maxillae	?	?

INFRACRANIAL

No catalogue designation was given to these numerous bones and fragments which were not assigned to a specific individual. A short summary of most of these miscellaneous bones follows:

Bone	Complete	Fragmentary	Adult	Subadult
Clavicle	2	9	10	1
Humerus	3	12	14	1
Radius	2	7	8	1
Ulna	2	8	8	2
Femur	1	16	15	2
Tibia	6	4	10	0
Fibula	1	8	9	0
Sacrum	3	0	3	0
Innominates	(7 ilium-ischia, 4 ischia, 5 ilia)			

1.6. Sample Size, Age and Sex Proportions

Remains of the two mound samples under consideration are representative of about ninety-nine individuals (46 from To-At-1 and 53 from To-At-2); because of the sizable uncatalogued and miscellaneous category, a more exact enumeration was not possible. Close adherence to the archaeological record makes my estimate a safe one, not greatly differing from the number of individuals said to have been excavated.

Tables 1 and 2 assign each individual to an age category as well as a sex designation in some cases. A summary of adult and subadult age-groupings is presented in Table 3 according to mound association.

The sample from To-At-1 reveals an excess of subadults (52.2%) over the adult representation, with the highest incidence (37.5%) of deaths occurring before one year of age, contrasted to To-At-2 where there is a predominance of adults (73.6%). However, it is of note that the majority of the subadults from To-At-2 are under four years of age. This disparity in age-group proportions might be the result of a number of factors alone or in conjunction: (1) a high infant mortality rate; (2) selective (con-

scious or unconscious) use of the burial site; (3) absence of much of the adult population at time of mound construction; (4) non-random deposition of burials within the mound; (5) a cultural practice such as interment of a sacrificial infant relative with an adult burial. To-At-2's age-group proportions may be attributed to negative or similar inferences made for To-At-1's alleged disproportionality or they might resemble the normal state of age-group proportions at death.

Since a fairly reliable cross-section of each mound was obtained, these age-group proportions are most probably a true picture of the entire structural mound entity. Secondary abstractions as to whether these samples are representative of a particular cultural or biological unit using these mounds as cemeteries is speculative as well as broader inferences regarding representation of the entire island of Tongatapu.

Mound To-At-1 may be broadly divided stratigraphically into an earlier and a more recent period. Less than half of the earlier burials were subadult, whereas more than half of the recent burials were of subadult status. There were few cases of immediate contemporaneous juvenile burying and many instances of highly disturbed infant deposition at the foot of adult burials.

Only two of the fourteen subadult burials of To-At-2 mound can be assigned to either an early or middle period of construction with the remaining twelve being deposited amongst the youngest interments and a number of these added very near the surface apparently in an unceremonious manner.

These added findings reveal a trend toward increased infant or subadult mortality. If pathological inferences are to be invoked, the skeletal remains do not seem to be of assistance in deciding an aetiology, as no inflammation or other evidence of bone pathology was found on gross inspection. Many of the infant burials appeared to be in good order and in an excellent state of preservation. As diseases which affect bone or come to affect bone are only a small minority of the total spectrum of pathologies, other disorders cannot be ruled out as causal from my negative evidence.

Because of the uncertainty (in many cases because of the incompleteness of the skeleton) of assigning a sex to each of the adult individuals, a sex ratio estimation is not practical, but three categories of sex according to mound membership are presented in Table 4. Visual inspection of assigned sex (male or female) reveals the incidence of males in To-At-1 as being twice as prevalent as females whereas To-At-2 has equal representation.

In summary, Mound To-At-1 appears to have atypical representation both in its age-group and sex proportions. To-At-2 appears more equally proportionate, with a temporal change of increased subadult mortality being experienced by both mound samples.

2. THE CRANIUM

2.1. General

A metrical and morphological study of the skulls was undertaken and will be presented in a regional format. The measurements taken and individual values are presented in Appendix 1 of this report, and mean values for male and female specimens are tabulated in Table 12. Adult cranial variations (both discrete and continuous) are presented in table form and incidence values will most often refer to adult cranial morphology with special instances of lumping of subadult and adult values where this was felt to be permissible.

2.2. Facial Morphology (Tables 5, 10, and 12)

Facial indices (Table 12) were calculated for only male representatives and are based on a small sampling. A range from 93.4 to 98.2 was arrived at for the gnathic index (Appendix 1 and Table 12). Euryenic (48.1) values were obtained for upper facial indices, and high readings (116.5) of hyperleptoprosopy were found for the total facial height (Table 12).

The orbital index (Table 12) for males ranges from extreme microseme (69.6) to low mesoseme (83.0) whereas the nasal aperture may be referred to as mesorrhinic, but with individuals ranging from leptorrhinic to platyrrhinic in this shape-value relationship.

The predominant form of the very few intact nasal bones was "hourglass shaped". A "blurred" effect was most often found to be descriptive of the subnasal region, other designated possibilities being "groove", "sulcus", or "sharp-line". This nondescript, smooth, moulded appearance was thought sometimes to be attributable to old-age and/or diseased state; these degenerative specimens automatically being lumped here, as well, when not strikingly pathological (Table 5).

No cases of "full metopic suture" were noted for the adult series, but a 62.5% incidence of a "persistent on brow ridge only" was found (Table 5) as compared with a 66.7% incidence for the subadult series (Table 10).

Bossing of the frontal bone most often was bilateral (60.9%) and only one instance of frontal grooving (4.3%) was found, occurring bilaterally in that case (Table 5). No frontal grooves were observed on subadult material (Table 10).

The supraorbital structure for transmitting nerves and vessels most often took the form of a spurred notch on both right and left sides with foramina occurring only half as frequently for the total series (Table 5). A single foramen was more often found in the subadult sample than the spur formation (Table 10).

"+V" brow ridge form was noted as most common in the adult population as a whole with females more often (87.5%) displaying a "++V" formation than males (Anderson 1962b, p. 111). This apparent sexual dimorphism may also explain the difference found when comparing mound incidences for this trait (Table 5).

Double infraorbital foramina occurred on both left and right sides with no striking sex difference or mound difference being observed (Table 5). This structure took the form of a single foramen in most subadult cases (Table 10).

No case of *os japonicum,* a horizontal suture dividing the zygomatic bone, was found in adult or subadult samples. A mound or lump on the anterior surface of the zygoma is here referred to as "malar tuberosity" and was scored on a 0, +, ++, +++ basis. It was found that a small incidence of 18.8% and 15.4% for the right and left respectively was present and confined to those individuals designated by me as male (Table 5). This trait was also observed in the subadult material (Table 10).

The "zygomaxillary tuberosity" of the inferior surface of the zygoma was scored also on a relative basis with about two-fifths of the specimens showing a "+" degree of muscle attachment; the higher incidence found for males was as expected (Table 5). Scoring of this trait on subadult individuals is speculative, but a relatively high incidence of some degree of expression was recorded (Table 10).

2.3. Basal Aspect (Tables 6, 10, and 11)

Only one case of palatine torus, a bony medial elevation of the palate, was noted for eighteen adult and four subadult potential and studiable specimens (Tables 6 and 10).

The sphenoid bone was usually not studiable, but of the seven right and twelve left sides observed, no unusual condition of the ovale-spinosum foramina complex was recorded. This was the case for the subadult individuals as well (Tables 6 and 10).

One case of a "precondylar tuberosity" (9.1%) and one instance of a "double precondylar tubercle" (9.1%) were observed for the adult sample (Table 6).

Ossified apical ligament formation was of low occurrence (9.1%). Paramastoid processes occurred in five of the eleven male skulls and were the only instances of this trait (Table 6) except for a unilateral expression on one subadult (Table 10).

The hypoglossal or anterior condylar canal was divided in 15.4 per cent cases of examined skulls (adult and subadult—Table 11) with no instance of an assigned female possessing one. No case of doubling was found for the five subadult skulls observed for this trait (Table 10). Posterior condylar canals were found more often in males (70.0%) than females (40.0%) with no differences in mound occurrence (Table 6). Of two subadult skulls, one showed bilateral expression of this trait, giving an overall incidence of 55.6 per cent for all studiable remains (Tables 10 and 11).

The occipital condyles were most often single (R1L1), oval and of convex structure (61.9% of adult and subadult cases—Table 11).

2.4. Interior (Tables 6, 10, and 11)

On the interior of the skull, the course of the groove for the superior sagittal venous sinus was felt (*lit.*) to have veered to the right (79.3%) more often than it veered to the left (10.3%) or provided a common connection for the transverse or lateral sinuses (10.3%—Table 11).

2.5. Vault (Tables 7 and 12)

The crania are largely mesocranic (M. 78.3, F. 77.1) fringing on brachycranic, with individuals ranging from dolichocranic to ultrabrachycranic (91.4). Using Lees' formula for computation of cranial capacity from length, breadth, and height values, a megacranic value (1514.2) is obtained for males and a comparable one (1311.7) for females taking the expected sexual difference into account. Both means are of an aristencephal category according to Sarasin (Martin 1957, p. 376). However, the range is again quite large for the male specimens (1371.8-1710.5) and high units of standard deviation are to be noted. Length-height and breadth-height indices reveal upper range values denoting hypsicranic and acrocranic respectively (Table 12).

No wormian bones were found along the coronal or sagittal sutural areas of adult or subadult specimens. Along the lambdoidal suture, however, 39% of the adult skulls showed one or more of these accessory bones. In only one case in twenty-three (4.3%) was an *os inca* (Fig. 4) or unfused superior portion of the squamous part of the occipital present. An obliteration or fusing of a once anomalous sutural line of this region was also scored as a "trace" for one individual (Table 7).

Sagittal keeling was scored on a 0, +, ++, +++ basis and this median elevation of the vault was quite common at the "+" degree of expression (77.3%). Parietal bossing was very pronounced with an incidence of 100%, with most cases being of the "++" variety and more pronounced at this degree amongst males. Bossing of this type was also observed in subadult material (Tables 7 and 10).

Parietal foramina were either absent or single with almost equal incidence being found for right and left (R 69.6%, L 65.4%—Table 7).

2.6. Lateral (Tables 8, 10, and 11)

No cases of marginal tubercles along the lateral borders of the zygoma were observed (Tables 8 and 10).

The formation of sutures at the pterion was most often fused, making observations impossible. Parietal notching was about as frequent on the right side as on the left, and one case of "parietal notch bone" was found; it occurred on the left in adult material. No cases of parietal notching were observed in the subadult material.

Accessory bones at the asterion were found in 31.3% of the adult skulls or 29.4% of all skulls (Tables 8 and 11).

FIG. 4—To-At-2-31. A superior view of the calvaria showing an *os inca* and osteoporosis of the parietal and occipital areas.

The occiput was varied in its expression with "mound (M)", "ridge (R)", "mound-ridge (M-R)", and "ridge-inion (R-I)" being the four main categories of description. Of these, the "ridge-inion" type was most frequent (50.0%), the others occurring approximately equally (Tables 8 and 10).

Mastoid processes were generally large or at least of a hanging, pendulant structure.

Notching of the posterior margin of the mastoid process occurred in 32.1% of the adult specimens (28 skulls) and in none of three subadults (Tables 8 and 10).

Of the tympanic region, thickening and perforation (dehiscence) were infrequently encountered (14.3% and 7.7% of the skulls respectively). "Auditory exostoses" were frequent (40.7%) and were most often extremely nodular at times occluding the auditory meatus (Table 8). No thickening or perforation was found for child skulls and a 25.0% (2/8) incidence of auditory exostoses was noted for these individuals (Table 10).

2.7. Mandible (Tables 9 and 10)

The mean values for mandibular measurements are to be found in Table 12 and individual measurements in Appendix 1.

Chin form was broadly classified as (M)—median (tapered to midline); (B)—bilateral (squared), and in combination with (A)—an arch angularity or "tenting" (Marshall and Snow 1956, p. 416) of the inferior border at the symphysis menti when viewed anteriorly. The six resulting categories appear to occur in equal frequencies, but with an apparent sexual dimorphism of the median form, as females have an incidence of 50.0% while males have an incidence of only 5.9%. In retrospect, angularity of the inferior borders was seemingly prevalent.

Torus mandibularis or bony outgrowth of the lingual surfaces of the mandible had a low incidence (5.7%). No tori were observed on the eleven subadult mandibles.

Gonial eversion was as frequent as gonial inversion, occurring in approximately one-third of the mandibles.

Bridging of the mylo-hyoid groove, on the interior surface of the ascending ramus, was found to occur only in an exaggerated form ("distal"), there being a long tunnel formation covering the nerve before its emergence inferiorly. No bridging was found among the subadult material.

There was only one instance (left side) of an adult mandible showing multiple mandibular foramina. Of thirteen subadult mandibles, two possessed multiple mandibular foramina.

Multiplication of the usually single mental foramen occurred in 17.1% of the adult mandibles examined (35). An incidence rate of 16.7% was recorded for subadults having this trait.

"Rocker jaw" (Fig. 5) occurred in males and females almost equally and was most often scored as "full" rocker jaw. An overall incidence rate of 67.6% was arrived at for "full" rocker and 8.8% for "slight" rocker. The "slight" category refers to unequal pivoting of the convex inferior borders usually rocking only when deflected at either the anterior (symphysis menti) or posterior (condylar) regions. A "full" rocker rocks evenly no matter where it is depressed. Eighty-three point three (83.3) per cent of the subadult mandibles showed this trait and usually of the "full" type.

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FIG. 5—To-At-2-1-C. "Rocker mandible" and maxilla; teeth showing buccal neck caries and calculus build-up.

Coronoid : condyle projection relationship revealed 56.5% of the mandibles showing equal heights attained by both processes and 30.4% having the coronoid process moderately exceeding the condyle's height.

2.8. SUMMARY OF SKULL

Tests of significance are largely unwarranted for the present findings without additional correction formulae being invoked. Chi-square testing was faintly justified in only two instances; the "Rocker jaw" trait and "coronoid : condyle relationship". For these two traits no significant difference was found for either male/female or Mound To-At-1/Mound To-At-2 differences.

A selected grouping of adult and subadult cranial variation incidences is presented in Table 11 as being representative of a totalled sample. Most of these variations are of a discrete nature making age differences less operative.

The crania were generally large well-rounded incasements possessing large parietal bosses, spurred supra-orbital notches, "V-shaped" brow ridges, plural infraorbital foramina, "hour-glass-shaped" nasal bones, a "blurred" subnasal region, posterior condylar canals, pendulant mastoid processes, accessory bones of the lambdoid suture, slight sagittal keeling, single parietal foramina, sutures often fused or in the process of fusing, "ridge-inion" occiput, and frequent "auditory exostoses".

The mandible was most often a "Rocker jaw" with various chin forms and arching of the inferior border a frequent feature.

3. DENTITION

3.1. General

An analysis of the maxillary and mandibular dentitions, though not attempted in detail, was not entirely neglected. The teeth, in most instances, were treated as a sample representation of a population (i.e., breeding unit) and in only a few cases will a specific individual be discussed, e.g., in presenting morphologically atypical manifestations. My analysis was directed to nonmetrical observations of the teeth and an appraisal of the dental health as inferred from the adult individuals at my disposal; no measurements being taken. More specifically, the morphological investigation was limited to mandibular molar fissure patterns, shovelling of the incisors, congenital absence, peg-shaped teeth, relative molar size progressions, and any other dental anomalies observable on gross inspection of teeth intact in their alveolar moorings. An assessment of dental health was based on the incidence of caries and alveolar abscesses present, attrition, premortem loss of teeth, and periodontal disease of the alveolus.

3.2. Methods and Number of Teeth Studied

Analysis of all dental observations was accomplished by entering the data on IBM cards (one per individual) and then sorting each column of the total adult sample which designated a specific trait or observation made. Totals (*n*) for the different observations will vary according to those areas which were studiable (i.e., intact and undamaged).

A maximum of 485 teeth of the maxillary dentition and 596 teeth of the mandibular dentition were studied representing 36 maxillae and 39 mandibles respectively. A breakdown as to specific tooth groupings can be estimated from Table 15.

3.3. Dental Morphology

mandibular fissure patterning (Table 13)

Six categories were found to characterize most generally the fissure patterns of the mandibular molar teeth of the present sample under consideration. These particular configurations are summarized as to their frequency of occurrence according to sex in Table 13. "+" patterns refer to cruciate grooves separating the cusps, whereas "Y" patterns have their mesio-lingual and disto-buccal cusps in contact (Anderson 1962b, p. 95; Dahlberg 1963, p. 170). "Crenulated +5" refers to a basic "+5" pattern with varied crenulations superimposed, whereas the "wrinkled" classification denoted a nondescript but highly crenulated pattern.

The first molar most often displays the "+5" pattern more frequently on the right side with an incidence of 64.7% for the total series. There is a higher occurrence in males than in females. Both sexes show a decidedly higher incidence rate of the "Y5" (so-called Dryopithecus pattern) on the left molar and an incidence of 26.5% for the entire series confined exclusively to the left side.

M2 is most often characterized as having the "+4" pattern occurring (72.1%) with the "+5" being the next most common type. A sex difference does not seem to be present nor is a side dissimilarity evident.

Third molars are similar to the first as the "+5" pattern is again prevalent with wrinkling occurring in 20.6% of the total series. Sex and side differences do not seem to be of importance or at least not predictable from the frequencies here observed.

"Crenulated +5" and wrinkled patterns were confined to the third molars.

SHOVEL-SHAPED INCISORS (Table 14)

No shovelling was observed in the 150 lower incisors. The trait was scored as either a "slight shovel" or "full shovel" for the 87 maxillary incisors inspected. The frequency of occurrence of any kind of shovelling on the lateral and central incisors was about equal with a marked sex difference as the females in each case possessed a higher incidence. A slight preference for central incisors over lateral incisors was also noted. Twenty-five point three (25.3) per cent of all incisors of the total adult series showed some kind of shovelling (see Table 14). These results are comparatively low for values cited by others for all Polynesia (Riesenfeld 1956, p. 513).

MOLAR SIZE PROGRESSION (mandibular)

In most cases the size progression: M1> M2> M3 was found to be typical with a slight tendency toward an equalization occurring distally and then encompassing the total molar group as the table below depicts.

		Number				Percentage			
Size progression		M.	F.	?	T.	M.	F.	?	Total %
M1> M2> M3		6	5	10	21	75.0	71.4	90.9	80.8
M1> (M2=M3)		0	1	1	2	0.0	14.3	9.1	7.7
M1 = M2 = M3		2	1	0	3	25.0	14.3	0.0	11.5
	n	8	7	11	26				

3.4. Anomalies and other Morphological Variation

PEG-SHAPED MOLARS

Two cases of diminution in size or pegging were observed. Individual *To-At-2-25* possessed what might be more properly termed a "reduced" molar, resembling any other molar in general morphology except that it was only about half the normal size. In this instance it was the left lower third molar. Extreme attrition and periodontal disease in addition to buccal abscesses were also noted for this individual along with exaggerated spacing of the teeth in both dental arcades.

The other case was a peg-shaped upper right third molar of a maxilla tentatively labelled *"MA2"*, as evidenced by its alveolar socket, the tooth being lost portmortem.

MESIAL ROTATION

At least three notable cases of mesial rotation or "winging" (Dahlberg 1963, p. 156) were observed. Individual *To-At-2-32* displayed unilateral rotation or winging of its lower right central incisor whereas *"B10"* had all four of its lower incisors obliquely set; each markedly counter mesially inclined. Individual *To-At-1-7* also displayed a rotated lower right lateral incisor.

CONGENITAL ABSENCE

The following individuals are thought to have congenital absence:
To-At-1-7. On gross inspection it is believed that the lower right central incisor of this individual was congenitally absent.
To-At-1-11. The lower left M3 of this specimen is believed never to have been present.

To-At-2-42. Hypodontia in this individual is demonstrated by the observed absence of the lower right lateral incisor.

As the above conclusions were made only on gross observation and without the aid of roentgenograms, their status as congenital absences is fairly tentative.

OTHER

To-At-2-27 was observed to have an accessory cusp distally placed on its lower left M3.

To-At-1-20's upper right central incisor showed a heaping up of its distal margin resulting in a pimple-like structure.

3.5. Postmortem and Premortem Tooth Loss (Table 15)

The incidence of postmortem loss of teeth in a population sample might provide an index to the structuring of the alveolar borders holding the teeth intact or, more likely, an indication of the amount of disturbance and handling after death and/or burial of the individual. Whatever reasons might be postulated, incidences of premortem and postmortem tooth loss have been tabulated for each tooth group in Table 15. As is most often the case the incisors are the most frequently dislodged with a progressive decrease distally into the molar series.

Premortem loss will be indicative of pathological, traumatic, and cultural factors experienced before the death of an individual. In the present adult sample, the lower molars were most often not present before death with a 20.8% incidence of loss. The remaining series seem to oscillate around a general mean of much lower incidence with an 8.7% value being calculated for the entire sample; a low value.

3.6. Attrition (Tables 16 and 17)

Attrition was scored on a "none", "slight", "blunted cusp", "dentine exposure", and "pulp exposure" basis on complete (or almost complete) maxillary and mandibular dentitions. Differences between sexes do not

appear to be evident nor can it be generally held that this particular sample is typical as having experienced extreme wearing of its occlusal surfaces. The incidence of attrition for anterior and posterior regions of the maxillary group are quite constant with a "slight" to "medium" amount of wear being evidenced in relative terms as a whole.

The attrition observed for the mandibular set is somewhat marked with the posterior region showing a slightly higher incidence over the anterior group.

3.7. Dental Pathology (Tables 18, 19, 20)

The incidence of the various types of caries found in the entire series of complete permanent dentitions of adults of both sexes was quantified as is shown in Table 18. Caries were categorized as either "buccal neck", "lingual neck", "interproximal (neck)", "deep occlusal", or "pit".

"Buccal neck caries" occurred most frequently while "lingual neck" and "deep occlusal" types were the least frequent. Neck caries were by far the most prevalent type, occurring almost twice as often as any occlusal type.

A total incidence of 8.3% for all types of caries for all teeth examined may be said to represent this sample with only a slight difference being cited for upper and lower dentitions.

Table 19 presents frequencies of all types of caries for each tooth group (upper and lower combined) which points to the greatest amount (13.2%) of involvement in the molar teeth with canines, premolars, and incisors being progressively less affected.

An abscess rate of 1.4% (14/1032) was arrived at for the total series with 11 of the 14 cases occurring in the mandible, the most frequent site being in the alveolar borders of the molar region (50.0%).

Periodontal disease was evidenced by "calculus build-up", "alveolar recession", and "rolled rim". Incidences for the various manifestations are summarized in Table 20 for maxillary and mandibular series on a 0 to +++ scale. Fragmentation often made this observation somewhat impossible and only complete, well-preserved specimens were used.

Concretions were quite marked in the selective sampling which might be attributed to functional-environmental causes rather than to pathology. However, recession of the alveolar margins are correspondingly marked and the occurrence of rolled rim is strong enough to support a pathological manifestation rather than a dietary-influenced one. From these observations, periodontal disease may be said to have a high rate of occurrence among the individuals with roughly two-thirds of the jaws being affected to some degree.

3.8. Summary

The sample under consideration may be characterized morphologically as most commonly having the "+5" fissure pattern on its molar teeth

(44.1%) with the "+4" pattern being the second most common; an incidence of 25.3% of its maxillary incisors depicting various degrees of shovelling; the molars decreasing in size distally; and sporadic cases of hypodontia, tooth rotation, and other anomalous traits.

The dental health can be summarized;—there is a low caries rate (8.3%) in all teeth, the most common type being the neck or interproximal variety occurring most often in the molars; an abscess rate of 1.4%; teeth wear not severe but rather of the cusp blunting type with dentine and pulp exposure infrequent; a low incidence of premortem loss (8.7%); and a fairly high occurrence of periodontal disease.

4. INFRACRANIAL

4.1. Vertebrae and Sternum

Morphological observations of the vertebrae were directed to variations of the superior articular surfaces, foramen transversarium, spinous processes of the cervical vertebrae, laminal spurring of thoracic and lumbar components and traits specific to C-1, C-2, and the sacral complex.

CERVICAL (Tables 21 and 22)

C-1.

The first cervical or atlas vertebra most often displayed a single, oval concave superior articular facet with no apparent sex differences observed; double and constricted structures being of minor occurrence. The foramen transversarium always took the form of a single aperture with differences in size frequently being noted.

No cases of "transverse bridging" (a ridge of bone extending from the superior articular process to the transverse processes) was observed, but three cases (sides) were observed to have a "posterior arch foramen" produced by a bony extension connecting the superior articular surface and the posterior arch of the vertebra.

C-2.

Two cases of an ossified apical odontoid ligament were recorded on the dens process of the second cervical or axis vertebra.

The superior articular processes and foramina transversaria were always single structures with equal expression of size being the commonest relationship of the foramina of C-2, C-3 and C-4.

The "spinous process" of this vertebra was most often (61.1%) of a divergent bifid variety with parallel bifid being the only other alternative.

C-3.

The third cervical vertebra frequently had a divergent bifid spinous process (62.5%) with a single non-bifid structure being the only other observed variation.

C-4.

The spinous process of this vertebra also was usually divergently bifid (54.5%) with the remaining instances of parallel bifid and single non-bifid being confined to male and female respectively.

C-5

The foramen transversarium was most often a single aperture with a doubling or spurred condition occurring relatively infrequently and the right foramen usually being smaller than the left (44.4%). The superior articular facet of this vertebra and of the remaining cervicals are all single structures. Three categories of spinous process variation were expressed almost equally.

C-6.

A single foramen was largely observed (64.3%) in the transverse processes of this vertebra, but doubling was not infrequent (32.1%). The side relationship was always disproportionate in size. A single, non-bifid spinous process was encountered a great deal.

C-7.

The foramen transversarium was most regularly a single aperture with division and spurring having a low incidence. Of three studiable

FIG. 6—To-At-2-13. Inferior view of seventh thoracic vertebra showing "laminal spurring".

vertebrae, all were observed to have the right foramen transversarium larger in relation to the left representatives. Except for two cases (11.1%), the spinous process was singular.

THORACIC, LUMBAR (Tables 23 and 24)

Laminal spurring (Fig. 6) had a high incidence and it occurred on either right and/or left superior and inferior lamina of thoracic and lumbar elements and was scored accordingly (16 categories) for each vertebra. For presentation purposes, all cases have been grouped into presence or absence as shown in Table 23. Highest incidences occurred from the fourth thoracic to the first lumbar vertebra with 69.7% of all thoracic and 35.0% of lumbar vertebrae showing this trait.

Incidences of laminal spurring for both males and females were high in the mid-thoracic and upper lumbar regions, but a very markedly increased rate was recorded for the female series. This apparent sexual dimorphism will be found later as being the case for osteoarthritic involvement of the articular facets of this same region of the vertebral column.

Measurements of the posterior bodies of the lumbar vertebrae were taken and these results and associated indices will be discussed along with stature calculations at the end of this section.

SACRUM (Table 24)

No cases of lumbarization of the first sacral vertebra or sacralization of the fifth lumbar element were observed.

Sacral hiatus of the sacral components, however, was extremely prevalent and will be discussed under pathology. Mention is made here of the incidence rates which are of note. Of the two types discerned, "superior" and "inferior sacral hiatus", the latter occurred in 80.0% of the fifteen sacrums studied and the former in 40.0% of eleven adult specimens studied, each to some degree of advancement (Figs. 7-8).

SUBADULT (Table 25)

Of the not yet mature individuals, incidences of morphological variations found in the vertebral column were much like those of the adult series. A few of these traits are presented in Table 25 with accompanying incidence rates. *Hiatus canalis sacralis* was evidenced for all five representatives of this age grouping and is discussed more thoroughly in the chapter on palaeopathology.

STERNUM

This highly fragmented bone displayed no case of the "sternal foramen" that is sometimes found at the junction of the third and fourth sternebrae.

4.2. UPPER LIMB (Tables 26 and 27)

CLAVICLE

The range of clavicular lengths was observed to be fairly constant with little difference for males (14.1 cm) and females (13.9 cm) being observed.

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FIG. 7—To-At-1-6. Sacrum with a "superior sacral hiatus" and a small inferior defect.

FIG. 8—To-At-2-26. "Inferior sacral hiatus" and a small superior defect.

Osteoarthritis of the articular surfaces of this bone, as well as others, will be discussed under degenerative changes in the section on palaeopathology.

SCAPULA

The presence of a "suprascapular notch" was more often observed (81.3%) than a "foramen" (6.2%) or an "absent" (12.5%) category for this area.

A classification of "rectangle", "triangle", and "sickle-shape" was observed for the shape of the acromion with a rectangular outline being the most prevalent type (76.5%).

The "inferior angle" of the scapula was found to present a V-shaped conformation one-third of the time with a blunted "U-shaped" outline occurring for the remainder. Too few cases make these findings speculative.

HUMERUS

A greater maximum length (32.3 cm) of the humerus was observed for males than for females (28.1 cm). Likewise, maximum and minimum head diameters were of a similar general relatedness as expected.

No cases of "supratrochlear spurring" were found, but a perforation or "septal aperture" piercing the olecranon and coronoid fossae was observed with an incidence of 15.4%. Unfortunately, five of the six observed examples were found in fragmented and miscellaneous material, making side and sex differences indeterminable and their status as an anomalous, not inflicted, trait uncertain.

RADIUS

Maximum length and maximum head diameter of this bone again revealed the expected sexual dimorphism and side difference; the right side exceeding the left in length.

ULNA

Values of 26.7 cm and 25.3 cm were recorded as being mean maximum lengths for males and females respectively for the ulna. The ulna was a more common site for a healed fracture than any other bone of the skeleton.

One case of a "distal spur" representative of an ossified ligament (articular disc ligament) of this area was found, being associated with a healed fracture.

4.3. Lower Limb (Tables 26 and 27)

INNOMINATE BONE

Thirty-four point eight per cent of the twenty-three potentially observable acetabular margins displayed an "acetabular notch".

FEMUR

Femora were lengthy, robust bones with little if any sexual dimorphism discernable; males (45.7 cm) and females (45.3 cm).

Mean values for platymeric indices of male (83.6) and female (81.8) specimens indicate a platymeric classification or considerable flattening of the subtrochanteric region. However, a range for individual indices was from hyperplatymeric to eurymeric (65.7 - 98.8). Difficulty was often experienced in taking the antero-posterior and lateral diameter measurements, mostly because of the degree of torsion and protrusion of bone in this region.

The pilastric index revealed a mean value of 114.8 for males and 110.7 for the female series.

A porous depression on the anterior surface of the neck of the femur, *Fossa of Allen*, was of low incidence (8.3%) and is thought to be concurrent with developmental processes (Anderson 1964, p. 51). This is also referred to by others as an *Empreinte* and has a high incidence among Maori femora (Schofield 1959, p. 98).

A proper "third trochanter" (tubercle structure similar to the "second trochanter") was never observed, but a "ridge" designation of varying degrees of expression was very common (96.8%).

TIBIA

The mean maximum lengths of female tibiae reveal a slightly longer (38.6 cm) bone than that value obtained for males (37.9 cm).

The platycnemic index for both sexes ranges from platycnemic to eurycnemic values, while the mean for males (66.6) is representative of a mesocnemic tibial mid-shaft and a eurycnemic (71.1) value was obtained

for the female group; females, therefore, may be said to possess a less flattened tibial mid-shaft region.

"Squatting facets" on the anterior distal extremity of the tibia were classified as "medial", "lateral", and "neck" facets. Seventy-five per cent of the tibiae capable of being observed for this trait showed some form, the various types being equally represented.

PATELLA

The patellae were observed to be most often strikingly pointed inferiorly and spurs not infrequent. Mean patella module values of 3.7 and 3.5 were obtained for male and female respectively.

Three cases of a *Vastus notch* (12.0%) in the superolateral angle at the site of attachment of the *Vastus lateralis tendon* were noted. No other anomalies characteristic of this bone were found to be present.

FIBULA

Very few fibulae were in a measurable state but a mean value for three male individuals was calculated to be 38.0 cm and one female (To-At-2-4) had a right fibula maximum length of 34.7 cm and a value of 39.9 cm for the left fibula.

CALCANEUS

Variation of the anterior and middle talar facets was categorized as "single", "double", or "constricted" entities with the "constricted" type or hour-glass formation occurring most often (72.2%) with no apparent sex or side difference. No other major categories of this variation were discerned.

NAVICULAR

The posterior surface of this bone was found to have two major variations occurring of five possible (Anderson 1964, p. 53). "Inferior extensions" occurred most often (65.2%) with "pitted tuberosity" being the other major classification.

TALUS

The so-called talar squatting facets were broadly defined as true "squatting facets" and "talar extensions" after Barnett (1954, pp. 509-510) with a modification of this basic scheme by inclusion of a "neck facet" category similar to Morimoto's "E_1" type on the superior surface of the neck of the talus originally described by Suzuki in 1950 (Morimoto 1960, pp. 161-162).

True "talar squatting facets" were most often of a "medial" kind (34.3%) with no apparent sex difference. A "medial extension" was more frequently (44.4%) observed for both sexes than any other classification.

SUBADULT (Table 28)

Very few traits of the very few immature long bones were able to be observed and recorded. A summarization of these selected traits is pre-

sented in table form (Table 28) along with a "Grand total" incidence computed for the majority of these morphological observations disregarding age, sex and side distinctions.

Measurements (maximum lengths) of subadult long bones by individual are to be found in Appendix 2.

4.4. Stature (Table 29)

By using various regression equations, an estimate of the living stature is obtained (see Trotter and Gleser 1958). Formulae incorporating different long bone maximum lengths were utilized so that estimates for a maximum number of individuals were obtained. The left length measurement was used when available and the same equations were used for male and female specimens. The most preferable equation available for an individual was used to represent that individual's estimated stature (Trotter and Gleser 1958, p. 120). No attempt to average the individual estimates, each usually utilizing different equations, for the total series was undertaken. Both Mongoloid and White equations were used, with White formulae probably being the better estimate.

These estimates are indicative of an anthropometrically tall people with a few individuals being found to approach and, in some cases, exceed six feet in height. (To-At-2-4 is outstanding as having been calculated as the tallest individual of the present sample.)

4.5. Limb Proportions (Table 30)

Only minimal limb proportion indices were able to be calculated and again visual inspection of the results is the only means of estimating a general tendency.

The brachial indices reveal a proportionately shorter forearm in contrast to the upper arm length for these individuals.

Tibio-femoral indices were all less than 83.0 with one exception, indicating a proportionately larger femur for all cases here presented. This is basically in accordance with White and Mongoloid values.

The intermembral index was low, indicating longer legs than arms exclusive of the distal extremities.

4.6. Posture

By measuring the posterior and anterior heights of the lumbar vertebral bodies, it was hoped to arrive at an estimate or conjecture concerning the posture of an individual from the concomitant indices.

The lumbar vertebral index will be indicative of posterior concavity or posterior convexity and associated with pathological changes. Only four vertebral indices were able to be calculated as all five intact lumbar vertebrae were necessary for this computation. However, the means all exceed 100 which indicates lesser posterior convexity of the lumbar region and is also the finding of the individual lumbar indices calculated for each lumbar vertebra (see Table 26).

4.7. Build

A very relative and subjective appraisal of build is gained through general robustness and muscle-markings found stamping the bones. In this case, the skeletal remains here studied were representative of a truly robust and highly muscular people. Clavicular robustness, heavy limb structuring, evidence of strong muscle attachment (and other sturdy indicators) are the evidence which support this view.

5. PALAEOPATHOLOGY

5.1. Introduction

Pathology will be dealt with systematically in several categories. For classificatory purposes, those diseases manifested on the bony remains will be grouped as degenerative changes or osteoarthritis, trauma, infectious diseases, congenital disorders, and any other evidences of pathology. Dental pathology has already been treated in the chapter on dentition.

5.2. Degenerative Changes

All degenerative changes or osteoarthritis of the articular surfaces on long bones, articular facets of vertebrae, and the marginal areas of vertebral centra were scored on a 0, +, ++, +++ basis. The frequency of occurrence of all types of arthritic involvement is presented in table form according to the assigned sex or mound association with side (R. or L.) being specified.

ARTICULAR SURFACES OF LONG BONES (Tables 31 to 37)

Lipping, spicules, spurring, pitting and other bone proliferations observed at the articular ends of long bone were lumped under the term "osteoarthritis". Such manifestations were relatively subdued in the present sampling, "+" being the usual score given if arthritic involvement was at all present.

Table 31 summarizes arthritic changes in the shoulder, elbow, and hip region. Medial and lateral extremities of the clavicle display similar amounts of complication.

Right and left glenoid fossae of the scapulae likewise show equal amounts of involvement with no apparent sex difference. Humeral heads are comparatively less affected, incidence being almost halved.

Capitulum, trochlea and the proximal articular surface of the ulna reveal a progressive increase in the amount of lipping with the frequency for females always higher than the males. In several instances, a percentage of 100 is assigned to the adult women and a total incidence of 87.1 per cent for arthritic involvement of the proximal ulnae is relatively outstanding even though sample sizes are somewhat small.

The sacro-iliac is another region of greater involvement whereas acetabulum and femur heads are less implicated. It may be worthy of

mention that of the eight male femur heads studiable, no degenerative manifestations were present, whereas two of the five females' articular surfaces did display degeneration.

Too few distal femur surfaces were studiable with a slight improvement among the proximal tibiae. These two areas along with patellae denote the knee region in Table 32. The usual arthritic complication of the patella was superior spurring which occurred in half of the specimens. The proximal end of the fibula was also noticeably involved.

Articular lipping was quite pronounced in the wrist region as may be surmised from Table 33. Arthritic changes of the metacarpals of the right and left hand were compared on a mound basis and a remarkably high degree of correspondence was found. As expected, greater frequencies of occurrence were found for the proximal portions with MC-5 having the highest percentage and MC-3 the lowest (Table 34).

The ankle (Table 35) is a frequent site for degeneration with distal tibial and fibular surfaces possessing equal incidence rates. Talus, calcaneus, and navicular bones are subject to greater involvement than the other bones of the ankle.

The metatarsal (Table 36) articular surfaces appear less engrossed in degenerative changes than the metacarpals, again with the distal extremes showing little or no involvement. Proximal MT-1 reveals the highest incidence (51.5%) with remaining tarsals showing less but fairly equal amounts.

Observations of degenerative changes were made for individual phalanges where discernible, but have been lumped into proximal, medial and distal hand and foot phalanges with the exception of the phalanges distal to MC-1 and MT-1, which are presented separately (Table 37).

The proximal end of the distal phalanx of the first finger displayed osteoarthritis more often than the other sites on these phalanges. Likewise, the proximal distal phalanx of the first toe was also most often involved as expected. The remaining hand and foot phalanges show little or no involvement.

An attempt to weight the various degrees of involvement and to use a mean value was made by assigning values of 0, 1, 2 and 3 to 0, +, ++, and +++ scores respectively so that a value of 0 will indicate no degeneration and a value of 300 depicts the greatest amount of involvement possible. It was found that the proximal ulna is the site of greatest lipping and that distal radius and bones of the ankle are also generally arthritic. It was also found that in general the occurrence of osteoarthritis was not severe.

PRESACRAL VERTEBRAE (Tables 38-41 and Diagrams 1-4)

The superior and inferior margins of the vertebral bodies often display the bony proliferation referred to as osteophytosis (Bourke 1967, p. 362). This type of degeneration occurred more often in males than in females

(Table 38). Diagrams 1 and 2 permit one to discern visually the regions of the presacral vertebral column, as well as differences between superior and inferior borders, in which osteophytosis was more marked (modification after Stewart 1947, pp. 230-231; 1966, pp. 52-55). It can be seen that a greater amount of involvement is to be found in the lower lumbar and the lower cervical region with considerable reduction in the upper and lower thoracic region.

In general, the lumbar vertebral margins are more arthritic, followed by the cervical and then very closely, if not equally, by the thoracic vertebrae when summation of all frequencies for each region are compared.

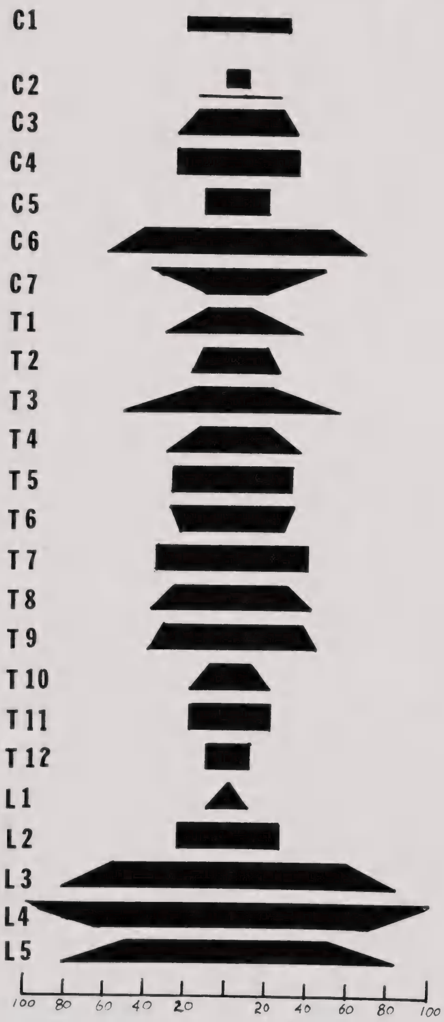

DIAGRAM 1—Osteophytosis of superior and inferior vertebral margins of the presacral vertebrae of Tongan males (5 to 15 representatives). Mean values were obtained by scoring on a 0 to 3 basis x 100.

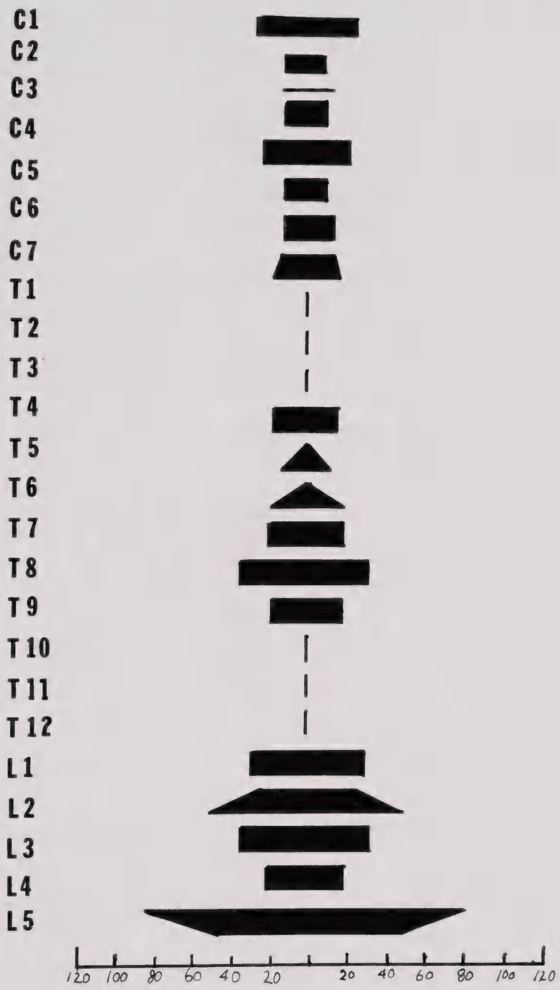

DIAGRAM 2—Osteophytosis of the superior and inferior vertebral margins of the presacral vertebrae of Tongan females (3 to 9 specimens).

Right and left superior and inferior articular facets of the presacral vertebrae were examined for osteoarthritis and percentages of any kind of involvement (+ to +++) have been tabulated (Tables 39, 40 and 41). The articular facets of C-1 and C-2 show greater complication than the remaining cervical vertebrae, again more so for the male series. The facets of the male thoracic region were relatively uninvolved whereas those of the female sample are in most cases markedly so, representing almost the converse of the cervical region in regard to sex-correlation. The lumbar region reveals a continuation of progressive involvement in the female line; osteoarthritis obtaining its greatest frequencies here. The lumbar region of the male shows no involvement until arriving at L-4 and L-5 and even then the frequencies do not rival the female incidences. For visual inspection, Diagrams 3 and 4 have been drawn.

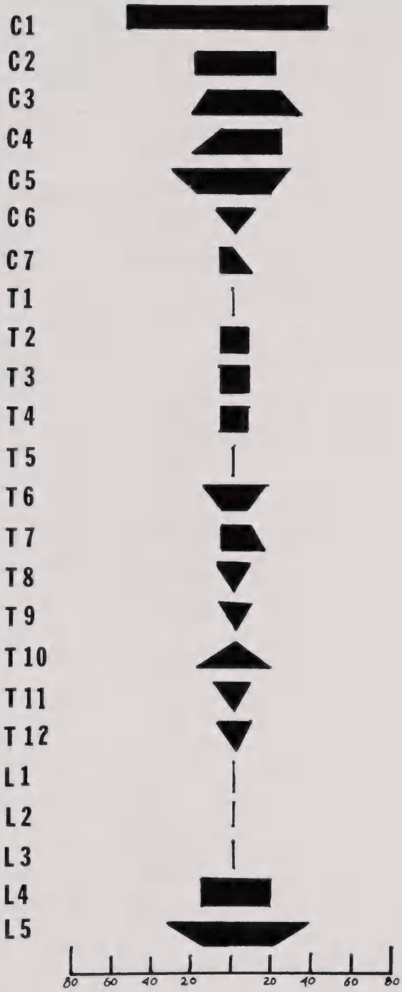

DIAGRAM 3—Osteoarthritic lipping of right and left superior and inferior articular surfaces of the presacral vertebral column of Tongan males (5 to 15).

SKULL (Tables 8, 9 and 6)

Osteoarthritis of the temporo-mandibular joint was found to have an incidence of 30.8% for male and 9.1% for female skulls (Table 8). A per skull incidence of 18.8% for males and 28.6% for females was found for arthritic involvement on the condylar surface of the mandible (Table 9).

An incidence of 58.8% was found to express some degree of arthritis occurring on the paired occipital condyles of the adult skulls examined (Table 6).

5.3. Trauma

It has been said that early closure of the cranial sutures could possibly be held responsible for the cranial deformation often noted for Tongan

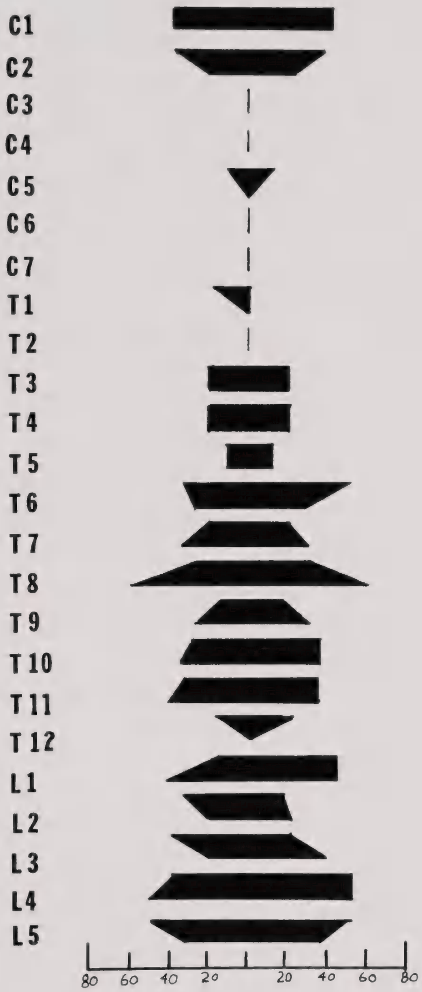

DIAGRAM 4—Osteoarthritic lipping of right and left superior and inferior articular surfaces of the presacral vertebral column as found in Tongan females (4 to 9). Comparatively greater arthritic involvement is observed to occur from mid-thoracic through the lumbar region as contrasted to the male sample.

crania including this collection (Marshall and Snow 1956, p. 420; Shima 1966, p. 140). However, no skulls were classified as such by the present researcher. Sixty-nine point six per cent of the coronal sutures in adults (23) were observed either to have fused (17.4%) or to be in the process of fusing. Fifty-four point two per cent of the sagittal and 26.1% of the lambdoid sutures (23) were in a similar condition.

Healed fractures were most commonly found in the forearm. Additional sites of fracturing were in the hand (phalangeal) and foot (metatarsal) skeletons. The other type of trauma found was a depression on the skull, probably due to a blow from a solid object, which was certainly not fatal.

Fractures were studied solely by gross inspection with callus formation, disalignment of the normal axis, and other deformities that follow breaking being the usual manifestations. It is quite conceivable then that some instances of early and well-healed fractures were missed, especially in the hand and foot regions. Furthermore, the clavicle, a commonly fractured bone, was not well represented or preserved. Only 'sure' cases will be presented here, according to their catalogue designation.

To-At-1-12. There is a finger-tip depression on the left parietal bone in contact with the left parietal foramen and circular in outline. It is probably a healed puncture wound.

To-At-1-34. (Fig. 9) The left ulna of this young male shows a distal fracture so well healed as to appear set purposely.

To-At-2-1-C. (Fig. 10) There are healed fractures of the right radius and ulna diagonal to one another. The radius is greatly disaligned, creating a large foramen and both fractures probably occurred in advanced adulthood.

To-At-2-4. (Fig. 11) The right ulna reveals a well-healed heavily calloused fracture occurring in its distal third.

To-At-2-18. Two proximal phalanges of the right hand show possible healed fractures. MT-5 in lateral view is quite noticeably bowed inferiorly. Furthermore, the left ulna revealed a healed fracture of its middle third accompanied by a great deal of callus formation (Fig. 12).

SUMMARY OF FRACTURES

Four ulnae and one radius were found to have healed fractures. The fractures of the male forearm were confined to the left limb, while those of the female were of the right limb. Other healed fractures and a healed puncture of the skull were also noted.

5.4. Infection

The individual cases to be presented here are thought to be due to diseases brought about by the invasion of infectious organisms. The manifestations will be grouped under treponematosis, which will include combinational treponemalseptic osteomyelitis pictures, less specific periostitis as found in the skull and typically severe cases of destructive changes found in the vertebral column. Classifying of the individual maladies as such implies a tentative diagnosis for these affected individuals.

TREPONEMATOSIS

To-At-1-4-B. (Figs. 13-31)

Almost all of the fragments that are representative of this individual are involved in similar bone lesions that are typical for the majority of the cases to be described in this section.

Three rib fragments were found to display a swollen and ulcerous cavitated cortex with occasional perforation and jaggedness of their inferior borders. The ulcerous depressions were only a few millimetres in diameter, separate and their margins vaguely outlined. X-rays revealed nodular

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FIG. 9—To-At-1-34. Left ulna displaying a healed fracture in its distal quarter.

FIG. 10—To-At-2-1-C. Poorly healed fractures of the distal right radius and ulna juxtaposed diagonally.

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FIG. 11—To-At-2-4. Right ulna revealing a healed fracture and resulting distortion.

FIG. 12—To-At-2-18. Left ulna showing a well-healed fracture (two ?) with heavy callus formation in mid and distal regions.

patches of lesser density in contrast to a heavier general interior. A cross section taken midway discerns a moderately dense matrix composed of a swollen lattice network (Figs. 13-15).

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FIG. 13—To-At-1-4-B. Rib fragment.
FIG. 14—X-ray of fragment.
FIG. 15—Transverse section taken at centre of fragment.
FIG. 16—To-At-1-4-B. Tibial mid-shaft fragment, showing a hypertrophied and tree-trunk-like appearance.
FIG. 17—X-ray of fragment.
FIG. 18—Cross-section at mid-point of fragment, showing a thickened periosteum and nodular lattice-work surrounding a 'decayed' cavity.

A mid-shaft fragment (tibia ?), noticeably swollen, showed roughened concavities externally with a greatly filled in medullary core at one end. On X-raying a dense matrix was apparent, especially at its immediate circumference, a much lesser density being found at its opposite extreme. Cross sectioning in its thicker region revealed osteoperiostitis involvement resulting in a thick sheath composed of a nodular lattice-system surrounding a 'decayed' cavity once probably veiled in an extremely fine and porous architecture of lamellae. At the opposite end of this fragment only a thin plate-like (sequestra) cortical layer remains with nothing adhering internally (Figs. 16-18).

A left humerus (distal half) fragment appeared externally swollen and characteristically pitted. The medullary cavity was greatly filled in distally by concentric circles of small similar manifestation as already noted with more extreme thickening occurring distally where there is a near or complete blockage of the medullary cavity (Figs. 19-21).

A (right ?) radius shaft fragment is enveloped in typical lesions along its entire length. A transverse section depicts a completely obliterated cavity in areas of greater cortical involvement, with a more normal internal appearance elsewhere, although here the cortex may be thinned more than is usual (Figs. 22-25).

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FIG. 19—To-At-1-4-B. Left humerus (distal half) in two pieces.

FIG. 20—X-ray of medial fragment.

FIG. 21—Cross section taken at the distal end of the medial fragment.

FIG. 22—To-At-1-4-B. (Right ?) radial fragment.

FIG. 23—X-ray of fragment.

FIG. 24—Cross section of fragment.

FIG. 25—Another cross section taken more distally.

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FIG. 26—To-At-1-4-B. Midshaft fragment (humerus?).

FIG. 27—X-ray of fragment.

FIG. 28—Transverse section taken at centre of fragment.

FIG. 29—To-At-1-4-B. Long bone (fibula ?) fragment.

FIG. 30—X-ray of fragment.

FIG. 31—Cross section of fragment.

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FIG. 32—To-At-1-21-A. Superior view of skull with multiple porous foci, some co-joining and creating large areas of destruction.

A mid-shaft fragment displays a general increment with large pitted cavities on its medial side. A cross section of this area reveals an occluded medullary cavity (Figs. 26-28).

Another shaft fragment appeared distorted and slightly inflated but greatly filled anteriorly, leaving a passageway of only about 1 mm in diameter (Figs. 29-31).

To-At-1-21-A. (Fig. 32) The reconstructed calvaria of this adult of unknown sex displays extensive destruction of the outer plate and part of the diploe in a side frontal-parietal (sagittal) area composed of ulcerous potholes of varying depths and expanse, with striations sometimes occurring

concentrically. These multiple foci of cratering sometimes meet nearby centres of destruction gouging out what must be new bone formation. The bone consistency appeared spongy and irregular.

A left ulna fragment, comprising the greater part of this bone, was characteristically swollen with ulcerous, single cavities pocking its surface. A left radius fragment and clavicle were apparently unaffected as well as the upper limb bones of the right side, excepting an intrusive (?) distal fragment of a right ulna also swollen and typical of the kind of pathology being described.

To-At-1-21-B. (Fig. 33) Both right and left tibial shaft fragments of this adult are characteristically pathological. One shows a typical concave and ulcerous depression while the other displays a more convex structure in an area of greatly thickened cortex.

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FIG. 33—To-At-1-21-B. Right and left tibial shaft fragments displaying typical treponemal lesions on their surfaces; porous oval concavities and swelling in areas of active affliction.

To-At-1-29-A. An adult male. The whole left tibia reveals an expanded shaft in the proximal region and more intense involvement anteriorly with little surface indication other than the already mentioned increment. Several holes observed in the condylar region are probably due to root growth rather than to pathology. No other bones representing this individual display a typical involvement.

To-At-2-5. (Figs. 34-36) A left fibula fragment (distal half) displays sharp, jagged linear margins. A denseness is shown in an X-ray of this fragment. A cross section exposes a well preserved, although very rigid cortical structuring which is probably atypically calcified. Other bones representative of this individual are confined to the foot which appears uninfected.

FIG. 34—To-At-2-5. Distal fragment of left fibula displaying jaggedness and stone quality.

FIG. 35—X-ray of fragment.

FIG. 36—Cross section taken in the distal part of the fragment superior to the fibular head.

FIG. 37—To-At-2-10. Fibular fragment.

FIG. 38—X-ray of fragment.

FIG. 39—To-At-2-37. Medial fragment of right tibial shaft.

FIG. 40—X-ray of fragment.

FIG. 41—Cross section taken at mid-point of fragment.

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FIG. 42—To-At-2-37. Distal fragment of right tibia, in two pieces, showing lesions typical of treponematoses and severe septic osteomyelitis.
FIG. 43—X-ray of distal components.
FIG. 44—Cross section taken medially.
FIG. 45—Cross section more distal to that shown in Fig. 44.
FIG. 46—Cross section taken still more distally.
FIG. 47—Cross section taken most distally, superior to area pierced by cloacae.

To-At-2-10. (Figs. 37-38) A left fibula shaft fragment missing its proximal and distal extremities appears densely thickened while its external surface keeps much of its design although rigid. Cross sectioning proved to be very difficult. The more accreted zone revealed a greatly reduced medullary cavity and a cortex of an extremely hardened and stonelike consistency. No similar expression was observed in the right tibia, fibula, and foot bones and fragments.

To-At-2-23. The right tibia (distal half fragment) of this individual displays typical swelling and ulcerous protrusions on its surface confined mostly to the distal third. The other skeletal representation of the lower limb including the left tibia does not show similar lesions.

To-At-2-37. (Figs. 39-47) A right tibia is in three major fragments, all highly pathological, revealing extreme septic osteomyelitis accompanied by large involucra, dead sequestral plates, distortion, and fusion distally with the right fibula into a monstrous bony mass. The tibia as a whole tapers to an extremely small diameter. More proximally it develops into a highly uncontrolled growth. Also associated with this bone assemblage is a left fibula fragment swollen and characteristically pathological.

The major fragments of the right tibia are:

(1) A distal third fragment, highly distorted with large involucra and foramina transversing its surface, swollen and markedly curved

inward (medially). Fusion of the right fibula is apparent distally but its extent superiorly is camouflaged and uncertain. Cross sectioning reveals a completely filled in cavity of compact silica-like consistency with the possible exception of a pin hole at its centre. X-ray confirms this solidity.

(2) A middle third fragment (a continuation of the distal fragment) narrows to a diameter of 19 mm or less. A transverse section shows a very reduced cavity filled in by a small core of porous bone and then surrounded by a more dense type. Another section, taken more proximally, still reveals an inflated centre although a passable cavity becomes evident at the mid-shaft point.

(3) A proximal third shaft fragment is greatly hypertrophied. Cross sectioning exposed a thickened cortex of dense matrix with a more fibrous inner consistency in addition to more dense, secondary increments concentrating around involucra and/or vessel passages within this cancellous network (sclerotic type margins). A more proximal section revealed a more porous and highly rarefied condition lightening the bone as a result.

The left tibia of this individual was unaffected.

MS1. This is a partially reconstructed skull of a female whose frontal bone is covered with flattened smooth lumps, a single ulcerous and rarefied centre being confined to the left supraorbital region.

To-At-1-10. This reconstructed calvaria revealed ulcerous centres of various sizes occurring mostly along the sagittal plane. At times these lesions take a fine porous nature sprinkling large areas of the parietal and

FIG. 48—To-At-2-21. Metatarsal bones of the left foot, with Mt-2 and Mt-3 revealing swollen areas distally and distortion (healed fractures ?).

frontal bones. No other pathology was noted except for the marked recession of the alveolar margins and moderate calculus build-up of the dental margins.

To-At-2-21. (Fig. 48) Metatarsal bones of the left foot of this individual were diagnosed earlier as healed fractures (no X-ray to confirm this) but because of their swollen nature and what appears to be a drainage cloaca on MT-3 and rarefication of the cortex accompanied by an oval excrescence on MT-2 their placement with other cases of infectious or treponemal diseases is quite plausible.

Other limb bone representation of this individual fails to show similar involvement.

VERTEBRAE

These single cases have been included here to differentiate them from a more generalized type pathology as they may be due to more specific vectors of an infectious origin and more prolific disease of the spine.

Fig. 49—To-At-2-13. Cervical vertebrae C-1 through C-7 in articulation.

To-At-2-13. (Figs. 49-50) The cervical vertebrae (C-3 through C-6) display much osteophytic involvement of their centra and lipping of their articular surfaces. Articular facets are largely obliterated by spongy masses, especially C-3 through C-5, whereas the bodies are wedge-shaped and eroded by cloacae internally.

To-At-1-12. (Figs. 51-52) The cervical vertebrae (C-2 through C-7) were observed to display extreme osteophytosis of their bodies; excessive lipping of their margins, erosions and drainage cloaca being evident. The

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FIG. 50—To-At-2-13. Inferior views of C-3, C-4, and C-5.

rest of the vertebral column was observed to be free of any type of osteophytic, degenerative, or pathological involvement as was true for the remaining skeletal parts.

To-At-2-18. The third, fourth, and fifth lumbar vertebrae of this specimen showed excessive lipping of the marginal area of their bodies associated with moderate internal erosive and drainage pathways.

SUMMARY

The pathology described under this heading is suggestive of treponematosis or osteomyelitis-producing agents either alone or in combination and is therefore worthy of summary. The typical lesions were found on ribs, humeri, radii, ulnae, tibiae, fibulae, metatarsal bones (?), vertebrae (?), and crania. Even though bone representation was not equal, the tibiae seem to be the bones affected (35.7% of the individual cases) most often and most severely. The fibula and ulna were also frequent sites. No cases of affliction of the clavicles, femora, innominate bones, or hand bones were noted. All thirteen individuals were adults. Only seven have been assigned a sex previously and of these, five were males (19.2% of known male population) and two were females (9.5% of the known female sample).

It is also apparent that we may be observing different stages of this disease and assurance is gained on reviewing radiological and clinical descriptions of more recent patients suffering from yaws (Davies 1961; Goldman 1943; Montel and Couput 1932).

To place a specific label on these cases would be highly presumptuous without other information since there is disagreement concerning even modern day cases of treponematoses in their diagnoses (syphilis and yaws

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FIG. 51—To-At-1-12. Posterior view of articulated cervical vertebrae C-2 through C-7.

FIG. 52—Superior views of same vertebrae revealing eroded bodies.

having similar clinical and radiological pictures) and also of the evolutionary course and/or environmental relationships. To say that these are definitely cases of yaws is therefore teleological and open to debate. In spite of the fact that my specimens are supposedly prehistoric and were once inhabitants of a tropical Pacific island, prerequisites which some say free a treponemal case from a 'syphilis' label (see Stewart and Spoehr 1952), a 'yaws' label cannot be definitely assigned because of the unsettled controversies over historical documentation, evolutionary (spatial and temporal) courses, and reliable diagnostic features of at least two modern day manifestations of this category of diseases. "Syphilis and yaws possess striking similarities" is the conclusion researchers of syphilis and yaws often arrive at after they give a few scant dissimilarities with reservations even for these (Hamlin 1939, pp. 29-30; Goldman and Smith 1943, p. 237; Stewart and Spoehr 1967, p. 318; Davies 1961, p. 25).

PERIOSTITIS-OSTEOPOROSIS-NEOPLASMS

To-At-2-13. A slight porosity of the brow region was noted for this individual in addition to a small nodule of bone (neoplastic) superior to the right supraorbital area comprising three small convexities to give only a slight mounding structure. A much larger buttonlike osteoma and a smaller one, anterior to it, were also observed on the left parietal bone near the sagittal midline. The cervical vertebrae have already been dealt with.

PERIOSTITIS-OSTEOPOROSIS

To-At-2-32. The fragmented remains here represented display periostitis-like characteristics. Soil erosion and acidity may or may not be attributed as the cause.

To-At-1-26. The parietal and occipital surfaces of this skull show a fine porosity reminiscent of small 'pin' pits. These may also be assigned to soil agents as these remains were observed to be slightly stained. No other pathology was observed in the infracranial bones.

To-At-2-31. (Fig. 4) Porosity of the vault surfaces of this individual's skull was also quite noticeable (cause ?).

5.5. Other Anomalies and Pathology

Hiatus canalis sacralis or the failure of fusion of posterior sacral halves appears to be a frequent trait among the present sample with both cephalad ("superior") and caudal ("inferior") bases to be considered in its description. Percentages for the different variations can be found in Table 24 which reveals a cephalad base approaching the S-1/S-2 junction to be the most common type (25.0%) and also a S-4/S-3 base for a hiatus arising caudally to be the most frequently encountered (26.7%).

Of five subadult sacra or fragments of this region, each individual represented displayed some expression of the defect. Three individuals revealed defects of the inferior sacral components but their origins and extent could not be determined. Of the two remaining cases, well developed hiatuses arising inferiorly and superiorly were observed.

Incidence rates for male and female are about equal with seven male and three females having one or both expressions. Two individuals (males) were observed to have the dual combination of hiatuses.

Inclusion of this variable trait under pathology is tentative as individuals with sacral hiatus variation may or may not have suffered from maladies associated with a clinician's description of *spina bifida* of the presacral vertebrae. However, extremely pathological cases affecting the entire skeleton have been attributed to the condition which I have been calling "superior sacral hiatus" (Rowling 1967, p. 278). This does not seem to be the case with these particular specimens as no gross pathological involvement was found to occur in association with this trait with the possible exception of To-At-1-6.

To-At-1-6. (Fig. 7) Both types of hiatuses were found in the sacrum of this middle-aged male. A "superior sacral hiatus" extends inferiorly to the junction of the second and third elements, while another defect reaches the S-4/S-5 region inferiorly. No other gross anomalies of the vertebral column of this individual or of the rest of the infracranial skeleton were in evidence. Cranial pathology is suspected, however, for this individual.

To-At-1-7. This aged male, although possessing a somewhat fragmented sacrum, revealed an "inferior sacral hiatus" extending up to the mid-S-4 element. Of the remaining skeletal remains of this individual, no other pathology except a peculiarity of the frontal region of the skull was noted.

To-At-1-29. Again, although the sacrum was damaged, an "inferior sacral hiatus" was found to reach the S-3/S-4 junction of this adult male with no other pathology being noted.

To-At-1-31. This adult male also displays an "inferior sacral hiatus" approaching the S-4/S-5 junction. Of the little other skeletal representation here, no additional pathology or anomaly was observed.

To-At-1-34. The "superior sacral hiatus" of this young adult male was similar to that of To-At-1-31.

To-At-2-4. A sacral hiatus was observed to reach the S-3/S-4 junction. Congenital absence of the first thoracic vertebra, pathological involvement of the sternal (cartilage) articular surfaces of the first ribs, an irregularity of the sternum, and a healed fracture of the right ulna, were also found in the skeleton of this supposedly adult female.

To-At-2-26. (Fig. 8) A hiatus extending downward to the S-1/S-2 junction and one extending upward to the S-2/S-3 union were observed in the sacrum of this adult female. No other gross pathology of the infracranial bones available for study was noted.

To-At-2-27. A female of unknown age with an "inferior sacral hiatus" approaching the mid-S-4 region is also of significance.

To-At-2-42. An adult male with a hiatus reaching inferiorly to the mid-S-2 component and a small defect reaching superiorly to the S-4/S-5 junction is here noted.

To-At-2-41. A fragment of the sacrum of this aged male revealed a hiatus but its extent was not able to be determined.

Miscellaneous. Three uncatalogued specimens possessed hiatuses which are included in the total incidences presented in Table 24.

HIATUS SACRALIS (subadult cases)

All of the subadult individuals possessing "sacral hiatus" were of a late adolescent age grouping.

To-At-1-14. A "sacral hiatus" was evident in the fourth and fifth sacral elements but its extent was uncertain owing to fragmentation of this individual's sacrum.

To-At-1-22. A "sacral hiatus" was observed in the small fragment representing this subadult.

To-At-2-1-E. An unfused posterior arch was evident in the fragment (fifth sacral vertebra) of this subadult.

To-At-2-11. A "superior sacral hiatus" was observed to penetrate as far as the S-1/S-2 junction and an "inferior sacral hiatus" approached the S-4/S-5 junction.

To-At-2-19. An almost complete sacral hiatus was here in evidence as an "inferior" hiatus reaching the mid-S-3 point and a "superior" hiatus was invoked as far as the mid-S-2 region.

UNDIAGNOSED

To-At-1-6. The skull of this middle-aged male appeared generally large and squarish. The brow ridges were not prominent but had a worn-down appearance. Bone resorption or a smoothing of the angularity of the nasal borders was also noticeable. Premortem loss of the maxillary

central and left lateral incisors and the left canine were also observed and the palate was noticeably deep. Of the infracranial skeleton, no other changes or pathology were of note except for *spina bifida* of the sacrum already discussed. Specimens of sclerotic arteries were found in association with this individual's skeletal remains.

To-At-2-4. The sternal articular ends of the right and left ribs of this adult are greatly swollen and the internal structure is of a spongy germinal consistency.

To-At-2-8. The tibiae of this individual are unusually bowed.

CONGENITAL ABSENCE OF VERTEBRAE

To-At-2-4. This individual also displayed a congenitally absent thoracic vertebra (first ?). Presence of five lumbar and all the cervical elements, articulation of the vertebrae present, and careful exhumation of this individual confirms at least that there is a deletion in the thoracic region unaccounted for except by an explanation of congenital absence.

The sternum of this individual revealed the articular surfaces to be set at an oblique angle on either side of the sternebrum and a spur (xiphoid) formation inferiorly. Healed fractures of the right radius and ulna have already been mentioned for this individual.

PHALANGEAL FUSION

To-At-1-12. The distal and medial phalanges of the left index finger of this individual were fused into one unit. A depression on the left parietal bone and pathology of the cervical region have already been noted.

To-At-2-5. Fusion of the medial and distal phalanges of the right fifth finger is here noted. A left fibula fragment of this same individual has already been described under "infection".

To-At-2-20. The medial and distal phalanges of the fifth finger of the right hand were observed to have fused together.

6. COMPARISONS (Table 42)

Since data comparable to the nature of my analysis (non-metrical morphology for the most part) are extremely rare for Polynesia and virtually non-existent for Western Polynesia, a spatial relationship within the Pacific area is impossible at this time. Comparable metrical analyses, however, are available and have been the bulwark of comparative studies from subjective and highly inferential diagnoses up to sophisticated statistical manipulations making use of distance formulae on living and osteological remains (Sullivan 1922, 1923; Shapiro 1943; Wagner 1937; Marshall and Giles n.d.). In view of the descriptive theme of this report, it is thought that a more consequential comparison could be advanced by examining data gathered on living subjects from a relatively modern era in contrast to my sample representative of an earlier period.

Such comparative data is largely of a metrical nature concerning the cranial region as this is the most easily equatable of somatological findings. Sullivan's monograph on living Tongans circa 1920 will be used for contrasting purposes (Sullivan 1922). Of the cranial measurements thought possible for this purpose, only five absolute dimensions and two indices were sought out as appropriate.

The original values for the living specimens were corrected by making use of facial skin thickness studies of His (1895) and Kollmann and Büchy (1898) and those suggested by Lee-Pearson when calculating cranial capacity from length, breadth and height measurements of the skull. These studies were mostly concerned with artistic restoration of the head to simulate appearance during life and are confined mostly to small cadaver samples (Krogman 1962, pp. 258-274).

Of these original five measurements singled out, probably only head length and width are to be considered as reliable. An arbitrary deduction of 8 mm was applied to the minimal frontal diameter as no data on skin thickness of this area was available in these studies. The bigonial diameter should also be closely scrutinized as His assigns a value of 24.16 mm to account for the thick musculature of this area, but Sullivan's readings were taken so as to avoid as much of this musculature involvement as possible. For this reason perhaps 10 mm is more reasonable.

Sullivan's original mean values and corrected values are to be found in table form along with mine for assessment (Table 42).

A test of statistical significance (t-Test) was computed for these temporally separated population samples and the trends to be discussed are based on their assigned statistical import.

The trend most emphasised, owing to the reliability of correction factors, larger sample sizes, and lesser variability, is that of a slight decrease in head length as shown by the male cranial results and associated greater cephalic index value implying a more brachycephalic population in recent times. Eleven millimetres were subtracted from these two measurements as recommended by Lee-Pearson (Martin 1957, p. 376; Wood-Jones 1929, p. 51). However, no statistically significant purport can be made for these findings.

The minimum frontal and bizygomatic diameters both suggest a narrowing of the face and a concomitant increase in the bizygomatico-frontal or frontal-jugal index, but only bizygomatic comparisons were found to be statistically significant and reliable.

Although not very reliable, the bigonial diameter is likewise in accordance with the general trend of facial narrowing to be expected in both males and females, but again the statistical significance found is highly tentative.

The differences are small and, for the most part, unsupported statistically as having any significance, a result which appears to be in accordance with Marshall's findings for Polynesia, of a 'conservative'

brachycephalization for crania representative of this area. Of the absolute value differences, probably the decrease observed for bizygomatic diameter is the most striking (11.3 mm).

Most researchers have remarked on the stability of the Tonga-Samoa complex in cranial and general morphology. My analysis does suggest a slight tendency towards a small decrease in head length and an increased head width in addition to a tapering of the face which are all very much in line with earlier findings but are not supported by the statistical test of significance used. The only outcome of statistical validity that might be cited is the apparent facial narrowing of the more recent representatives in comparison to the prehistoric sample under consideration.

APPENDIX 1

1. Description of cranial measurements.
2. Individual skull measurements for adult male and female series.

CRANIOMETRY

The thirty-two measurements taken and the indices calculated from them will be dealt with in this section. Sliding calipers (S.C.) and Hinge or spreading calipers (H.C.) were the two measuring instruments most used in this study.

1. Cranial Length. The length of the skull was taken as the distance between the most prominent point of the glabella and the most distant point posteriorly in the sagittal plane on the occiput (H.C.). Wood-Jones's No. 1; Martin's No. 1.

2. Cranial Breadth. Breadth was determined as the maximum transverse diameter of the skull above the supramastoid and zygomatic crest (H.C.). Wood-Jones's No. 1; Martin's No. 8.

3. Cranial Height. The height of the skull was determined by measuring the distance between the basion (anterior border of the foramen magnum) and the bregma (point where coronal and sagittal sutures meet) with the skull lying on its left side facing the examiner (H.C.). Wood-Jones's No. 1; Martin's No. 17.

4. Cranial Capacity. Capacity was calculated by use of Lee's formula using length, breadth, and height measurements. Male capacity = .000266 x (length=1) x (breadth =2) x (height=3) + 524.6. Female capacity = .000156 x (length=1) x (breadth=2) x (height=3) + 812.0 (see Comas 1960, p. 411).

5. Cranial Module (Schmidt's modulus). This index was determined by adding length, breadth, and height and dividing by 3.

6. Cranial Index. Length-breadth index was determined by using the formula: $\frac{\text{breadth}=2}{\text{length}=1} \times 100.$

7. Height Index: length-height index = $\frac{\text{height}=3}{\text{length}=1} \times 100.$

8. Breadth-Height Index: $\dfrac{\text{height}=3}{\text{breadth}=2} \times 100.$

9. Basion-Nasion Length: the distance as measured by H.C. between the nasion (point of intersection of internasal and nasofrontal sutures) and basion landmarks. Wood-Jones's No. 1.

10. Basion-Prosthion Length. This measurement was taken as the distance between the alveolar point (the lowest point on the alveolar margin of the upper jaw between the two central incisors) and basion (H.C.).

11. Gnathic Index: alveolar index. Wood-Jones's No. 7.

12. Minimum Frontal Breadth: the shortest horizontal diameter between right and left temporal lines on the frontal bone (H.C.). Wood-Jones's No. 4; Martin's No. 9.

13. Bizygomatic Breadth. Facial breadth was taken as the greatest distance between points on the external surface of the zygomatic arches (H.C.). Wood-Jones's No. 1; Martin's No. 45.

14. Upper Facial Height. Measured as the distance between nasion and prosthion (S.C.). Wood-Jones's No. 2.

15. Upper Facial Index: $\dfrac{\text{upper facial height}=14}{\text{bizygomatic breadth}=13} \times 100.$

16. Total Facial Height. This was taken as the distance from the nasion to the gnathion or menton (median point on the inferior margin of the symphysis) (S.C.). Wood-Jones's No. 1; Martin's No. 47.

17. Total Facial Index: $\dfrac{\text{total facial height}}{\text{bizygomatic breadth}} \times 100.$

18. Orbital Breadth. Orbital breadth was interpreted as the maximum width of the orbit from the maxillofrontale (point upon the inner orbital wall at which the frontal, ascending process of the maxilla, and anterior lacrimal crest meet) to the middle of the lateral border of the orbit (S.C.). Martin's No. 51.

19. Orbital Height. The height of the orbit was taken as the maximum distance perpendicular to the plane of the superior and inferior borders of the orbit (S.C.). Wood-Jones's No. 2.

20. Orbital Index: calculated from the formula: $\dfrac{\text{orbital height}=19}{\text{orbital breadth}=18} \times 100.$

21. Nasal Breadth: the distance obtained as the greatest diameter of the lateral border of the nasal aperture measured in a horizontal plane (S.C.). Wood-Jones's No. 2; Martin's No. 54.

22. Nasal Height. The height of the nasal region was taken as the distance from the nasion to the mid point of a line connecting the right and left nasal fossae. Wood-Jones's No. 1; Martin's No. 55.

23. Nasal Index: $\dfrac{\text{nasal breadth}=21}{\text{nasal height}=22} \times 100.$

24. Maxillo-alveolar Breadth. This palatal measurement was obtained by measuring the maximum transverse separation of the alveolar arch lateral to the molar teeth (S.C.). Wood-Jones's No. 1; Martin's No. 61.

25. Maxillo-alveolar Length: the distance as measured from the prosthion to the middle of a transverse line connecting the posterior extremities of the alveolar border (S.C.). Wood-Jones's No. 2; Martin's No. 60.

26. Maxillo-alveolar Index: $\dfrac{\text{breadth}=24}{\text{length}=25} \times 100.$

27. Bigonial Diameter: the distance measured from the lateral margins of one gonion to the other (vertex of angle between ramus and body of mandible) (S.C.). Wood-Jones's No. 2; Martin's No. 66.

28. Symphysis Height: the mandibular measurement taken inferiorly from the gnathion to the highest point of the alveolar border between the medial incisors (S.C.). Wood-Jones's No. 5; Martin's No. 69.

29. Ramus Height: the distance from the uppermost projection of the condyle to the gonion (S.C.). This mandibular measurement was often difficult to obtain due to the nondescript nature of the ramus-body junction, morphologically characterized as 'Rocker Jaw'. Wood-Jones's No. 3; Martin's No. 70.

30. Ramus Breadth. A minimum breadth of the ascending ramus was obtained by measuring the distance between the anterior and posterior borders of only the left ramus when both were present (S.C.). Wood-Jones's No. 4a; Martin's No. 71a.

31. Mandibular Length. By aligning the mandible at the condyles posteriorly and at the symphysis anteriorly and taking that distance (condyle-symphyseal length) a measure of mandible length is obtained. Again, in cases of 'Rocker Jaw', this measurement was difficult and results tentative.

32. Bicondylar Width. The width between the condyles is taken as the distance separating their external surfaces (S.C.). Wood-Jones's No. 1; Martin's No. 65.

INDIVIDUAL CRANIAL VAULT MEASUREMENTS OF TONGAN MALES

	CRANIAL				INDICES				FACIAL								ORBITAL			NASAL			ALVEOLAR		
	Length	Breadth	Height	Capacity	Module	Cranial	Length-height	Breadth-height	Basion-nasion	Basion-prosthion	Gnathic index	Minimum frontal	Bizygomatic diam.	Upper facial ht.	Upper facial index	Total facial ht.	Total facial index	Breadth	Height	Index	Breadth	Height	Index	Breadth	Height	Index
To-At-1-6	174	155	147	1415.5	158.7	89.1	84.5	94.8	106	99	107.1	107	145	75	51.7	—	—	47	39	83.0	28	62	45.2	68	53	128.3
To-At-1-7	186	170	141	1710.5	165.7	94.4	75.8	82.9	108	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-9	191	140	155	1627.1	162.0	73.7	81.2	110.7	111	—	—	89	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-10	196	—	—	—	—	—	—	—	—	—	—	110	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-19	175	130	140	1371.8	148.3	74.3	80	107.7	—	—	—	105	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-21A	175*	—	—	—	—	—	—	—	—	—	—	112	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-6	181*	140	—	—	—	77.3	—	—	—	—	—	98	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13	177	145	145	1514.5	155.7	81.9	81.9	100	110	108	101.9	106	140	66	47.1	120	85.7	45	36	80.0	29	51	56.9	64	61	105.0
To-At-2-13A	178	138	141	1445.9	152.3	77.5	79.2	102.2	108	104	103.8	95	143	65	45.5	113	79.0	46	32	69.6	28	53	52.8	62	56	110.7
To-At-2-31	191	141	—	—	—	73.8	—	—	—	—	—	96	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-33	—	144	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-41	196	142	—	—	—	72.4	—	—	—	—	—	110	—	—	—	—	—	—	—	—	—	—	—	—	42	—
MS1	185	137	—	—	—	74.1	—	—	—	—	—	102	—	—	—	—	—	—	—	—	—	—	—	—	—	—
?	175	134	—	—	—	76.6	—	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MM2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	68	63	107.9

* An approximate value.

INDIVIDUAL CRANIAL VAULT MEASUREMENTS OF TONGAN FEMALES

	CRANIAL				INDICES				FACIAL									ORBITAL			NASAL			MAX-ALVEOLAR		
	Length	Breadth	Height	Capacity	Module	Cranial	Length-height	Breadth-height	Basion-nasion	Basion-prosthion	Gnathic index	Minimum frontal	Bizygomatic height	Upper facial ht.	Upper facial index	Total facial ht.	Total facial index	Breadth	Height	Index	Breadth	Height	Index	Breadth	Height	Index
To-At-2-1C	170	123	138	1262.2	143.7	72.4	81.2	112.2	101	—	—	90	—	—	—	—	—	—	—	—	—	—	—	66	55	120.0
To-At-2-24A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55	—	—
To-At-2-40A	171*	131*	—	—	—	76.6	—	—	—	—	—	103	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-MS3	181	137	—	—	—	75.7	—	—	—	—	—	100*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-MS4	171	143	144	1361.3	152.7	83.6	84.2	100.7	110	—	—	101	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-MS5	170	—	—	—	—	—	—	—	—	—	—	94	—	—	—	—	—	—	—	—	—	—	—	—	—	—

* An approximate value.

INDIVIDUAL MANDIBULAR MEASUREMENTS FOR MALE AND FEMALE TONGANS

	Bigonial diameter	Symphysis height	Ramus height	Ramus breadth	Mandibular length	Bicondylar width
MALE						
To-At-1-6	106*	28	70	37	102	—
To-At-1-7	88	28	59	39	—	127
To-At-1-9	112	34	65	38	108*	—
To-At-1-10	94	27	56	38	114	116
To-At-1-11	91	31	54	38	113	124
To-At-1-29	115	33	75	42	116	137
To-At-1-34	108	24	66	43	111	134
To-At-2-6	100	31	54	32	112	—
To-At-2-13	103	31	51	38	111	130
To-At-2-13A	106	28	64	35	107	124
To-At-2-18	91	26*	61	30	101	127*
To-At-2-31	95	34	66	40	107	126
To-At-2-33	—	29	63	37	107	114
To-At-2-41	115*	35	65	46	106*	135*
To-At-MA1	103	35	60	34	115	124
To-At-MM2	107	28	68	40	109	138
M1	94	28	61	36	114	122*
MM5	92	29	45	33	90	109
FEMALE						
To-At-1-4A	—	—	68*	40	—	—
To-At-1-19	—	—	62	38	—	—
To-At-1-20	93	34	66	42	118	—
To-At-1-21B	—	27	—	—	—	—
To-At-1-27	101	32	51	34	103	121
To-At-2-1C	95	30	65	36	111*	—
To-At-2-24A	—	30	—	—	—	—
To-At-2-24B	—	31	—	33	—	—
To-At-2-25	94	26	59	36	104	—
To-At-2-40A	98	28	60	34	105	132

* An approximate value.

APPENDIX 2

1. Description of infracranial measurements taken.
2. Individual infracranial measurements of adult and subadult material.

INFRACRANIAL MEASUREMENTS AND INDICES

Infracranial measurements and their derived indices made in this study are outlined in this section. References to recognised schemata of osteometry are appended after each entry as in Appendix 1. The maximum lengths of the long bones were determined by use of an osteometric board (O.B.).

CLAVICLE

1. Maximum or Direct Length. This measurement was taken as the greatest length between the sternal and acromial extremities of the clavicle (O.B.). Wood-Jones's No. 1; Martin's No. 1.

HUMERUS

2. Maximum Length. Maximum lengths of all long bones were determined by placing them on the osteometric board in anatomical position and then pivoting them at their proximal extremities until a maximum length parallel to the board's surface was achieved (O.B.). Wood-Jones's No. 6; Martin's No. 1.

3. Minimum or Transverse Head Diameter: the transverse diameter of the proximal articular surface of the humerus (S.C.). Wood Jones's No. 12; Martin's No. 9.

4. Maximum or Sagittal Head Diameter: similar to the above measurement except that it is the vertical diameter of the humeral head. Wood-Jones's No. 11; Martin's No. 10.

ULNA

5. Maximum Length: (O.B.). Wood-Jones's No. 18; Martin's No. 1.

RADIUS

6. Maximum Length: (O.B.). Wood-Jones's No. 15; Martin's No. 1.

7. Radial Head Diameter: (S.C.). Taken as the maximum diameter of the radius head (Montagu 1960, p. 620). Montagu's No. 2.

FEMUR

8. Maximum Length: the maximum distance between the extremities of the femoral head and internal condyle (O.B.). Wood-Jones's No. 15; Martin's No. 1.

9. Maximum Head Diameter: (S.C.). Wood-Jones's No. 30; Martin's No. 15.

10. Subtrochanteric Antero-Posterior (A-P) Diameter: the sagittal diameter of the shaft taken at right angles to the long axis just below the "lesser trochanteric" protrusion (S.C.). Wood-Jones's No. 29; Martin's No. 10; Montagu's No. 16.

11. Subtrochanteric Lateral (Lat.) Diameter: transverse diameter, maximum diameter, or the medio-lateral diameter of the shaft at the subtrochanteric level. Difficulty is sometimes experienced in taking these diameters owing to the irregularities of this region in Polynesian skeletal remains—the so-called "platymeric protrusion" (Schofield 1959, p. 95). Wood-Jones's No. 28; Martin's No. 9; Montagu's No. 17.

12. Platymeric Index. This index is found by using the formula:

$$\frac{\text{subtrochanteric (A-P) diameter}=10}{\text{subtrochanteric (Lat.) diameter}=11} \times 100.$$

13. Antero-Posterior Diameter. This measurement is taken at the mid point of the femur's maximum length (S.C.). Wood-Jones's No. 25; Martin's No. 6; Montagu's No. 19.

14. Lateral (Transverse) Diameter. The *linea aspera* is kept midway between the arms of the calipers in taking this measurement (S.C.). Wood-Jones's No. 26; Martin's No. 7; Montagu's No. 20.

15. Pilastric Index: $$\frac{\text{A-P diameter}=13}{\text{Lat. (trans) diameter}=14} \times 100.$$

TIBIA

16. Maximum Length. This includes the spine and "medial malleolus" (O.B.). Wood-Jones's No. 37; Martin's No. 1a.

17. Transverse Diameter of Shaft. The diameter was taken at the level of the nutrient foramen (S.C.). Wood-Jones's No. 43.

18. Antero-Posterior Diameter of the Shaft: taken in a sagittal plane at the level of the nutrient foramen (S.C.). Wood-Jones's No. 44.

19. Platycnemic Index (Cnemic index): $\dfrac{\text{transverse diameter}=17}{\text{A-P diameter}=18} \times 100.$

FIBULA

20. Maximum Length. The "lateral malleolus" was included in this measurement (S.C.). Wood-Jones's No. 47; Martin's No. 1.

PATELLA

21. Height: maximum vertical diameter (S.C.). Wood-Jones's No. 34; Martin's No. 1.

22. Width: maximum transverse diameter (S.C.). Wood-Jones's No. 35; Martin's No. 2.

23. Thickness: maximum thickness (S.C.). Wood-Jones's No. 36; Martin's No. 3.

24. Patella Module: $\dfrac{\text{height}=21 + \text{width}=22 + \text{thickness}=23}{3}$

LUMBAR VERTEBRAE

25. Posterior Height: height measurement taken on the posterior half of the vertebral body, or more precisely the distance between the middle of the posterior-superior border and the middle of the posterior-inferior border of the centrum (S.C.) (Montagu 1960, p. 625). Martin's No. 2; Montagu's No. 30.

26. Anterior Height of the Centrum: taken from the middle of the anterior-superior border to the middle of the anterior-inferior lip of the centrum (S.C.). (op. cit.). Martin's No. 1; Montagu's No. 29.

27. Lumbar Index: $\dfrac{\text{posterior height of the centrum}=25}{\text{anterior height of the centrum}=26} \times 100$

(Anderson 1963, p. 125).

28. Lumbar Vertebral Index: $\dfrac{\text{sum of posterior heights of centra}}{\text{sum of anterior heights of centra}} \times 100$

(op. cit., p. 126).

29. Radio-Humeral Index (Brachial index): $\dfrac{\text{maximum length of radius}=6}{\text{maximum length of humerus}=2} \times 100$

30. Intermembral Index: $\dfrac{\text{length of humerus}=2 + \text{radius}=6}{\text{length of tibia}=16 + \text{femur}=8} \times 100$

31. Tibia-Femur Index (Crural index): $\dfrac{\text{tibia length}=16}{\text{femur length}=8} \times 100$

32. Femur-Humeral Index: $\dfrac{\text{length of humerus}=2}{\text{length of femur}=8} \times 100$

33. Tibia-Radial Index: $\dfrac{\text{length of radius}=6}{\text{length of tibia}=16} \times 100$

INDIVIDUAL MEASUREMENTS OF TONGAN MALE INFRACRANIAL REMAINS (1)

	CLAVICLE Length		HUMERUS Length		Min.hd.di.		Max.hd.di.		ULNA Length		RADIUS Length		Hd.di.		FEMUR Length		Hd.di.		R.Subtrochanteric diameter		Platymeric index
	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	A-P	Lat.	
To-At-1-6	144	149	—	320	44	44	46	49	272	269	255	252	24	23	460	462	47	47	29	34	85.3
To-At-1-7	—	—	—	309	—	—	—	46	261	—	—	237	—	24	—	—	47	—	24	33	72.7
To-At-1-10	130	132	334	332	43	—	48	47	270	—	254	254	22	23	—	443	—	46	—	—	—
To-At-1-10B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	474	457	48	48	28	35	80.0
To-At-1-12	—	—	—	—	43	—	46	—	271	—	—	249	—	24	—	—	47	48	26	27	96.3
To-At-1-21A	—	—	—	330	—	42	—	41	—	—	—	—	25	26	—	474	—	49	—	—	—
To-At-1-29	—	—	331	336	42	42	48	48	286	260	—	—	—	—	449	449	—	48	28	34	82.4
To-At-1-31	—	—	—	—	—	—	—	—	—	—	—	—	25	—	—	—	50	—	28	32	87.5
To-At-1-34	150	—	328	—	43	—	46	—	281	—	261	—	24	—	462	—	50	—	30	32	93.8
To-At-2-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-6	136	134	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13	—	142	—	320	43	42	45	46	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13A	142	*139	322	319	43	44	46	46	252	250	241	239	24	24	—	—	—	—	—	—	—
To-At-2-13C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-22	—	140	324	326	—	41	42	42	262	254	240	241	22	22	—	—	—	—	—	—	—
To-At-2-22A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-31	146	—	—	—	—	—	—	—	—	—	—	—	—	—	—	455	—	50	—	—	—
To-At-2-33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-42	134	—	309	308	39	—	44	42	—	—	—	—	22	—	—	—	46	46	25	31	80.6
To-At-2-44	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

* An approximate value.

INDIVIDUAL MEASUREMENTS OF TONGAN MALE INFRACRANIAL REMAINS (2)

	FEMUR									TIBIA							
	L di. & index			R ½ di. & index			L ½ di. & index			Length		R di. & index			L di. & index		
	A-P	Lat.	Platymeric	Tran.	A-P	Pilastric	Tran.	A-P	Pilastric	R	L	Tran.	A-P	Platycnemic	Tran.	A-P	Platycnemic
To-At-1-6	29	37	78.4	26	32	123.1	26	32	123.1	383	383	27	39	69.2	27	39	69.2
To-At-1-7	25	33	75.8	27	29	107.4	27	27	100.0	—	350	—	—	—	23	33	69.7
To-At-1-9	26	33	78.8	—	—	—	28	31	110.7	363	—	25	39	64.1	—	—	—
To-At-1-10	—	—	—	25	34	136.0	—	—	—	—	—	31	41	75.6	—	—	—
To-At-1-10B	28	33	84.4	29	29	100.0	27	33	122.2	—	—	—	—	—	—	—	—
To-At-1-12	27	32	84.4	—	—	—	27	29	107.4	391	—	27	39	69.2	26	37	70.3
To-At-1-21A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-29	30	34	88.8	26	36	138.5	30	36	120.0	391	—	29	44	65.9	30	44	68.2
To-At-1-31	—	—	—	28	30	107.1	—	—	—	—	—	24	36	66.7	—	—	—
To-At-1-34	—	—	—	30	37	123.3	—	—	—	—	—	—	—	—	—	—	—
To-At-2-5	—	—	—	—	—	—	—	—	—	398	395	21	42	50.0	21	43	48.8
To-At-2-6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13C	—	—	—	25	29	116.0	25	27	100.8	—	—	—	—	—	—	—	—
To-At-2-22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-22A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21	35	60.0
To-At-2-31	26	31	83.9	—	—	—	26	32	123.1	—	—	—	—	—	—	—	—
To-At-2-33	—	—	—	26	27	103.8	—	—	—	—	—	—	—	—	—	—	—
To-At-2-35	—	—	—	25	30	120.0	—	—	—	—	—	24	34	70.6	26	36	72.2
To-At-2-37	—	—	—	—	—	—	—	—	—	383	—	24	38	63.2	24	35	68.6
To-At-2-42	25	31	80.6	—	—	—	—	—	—	—	—	—	—	—	27	42	64.3
To-At-2-44	—	—	—	29	32	110.3	—	—	—	—	—	—	—	—	25	37	67.6

INDIVIDUAL MEASUREMENTS OF TONGAN MALE INFRACRANIAL REMAINS (3)

	FIBULA Length		R PATELLA				L PATELLA				LUMBAR VERTEBRAE L1			L2			L3			L4			L5		
	R	L	Lg.	Wd.	Ht.	Mod.	Lg.	Wd.	Ht.	Mod.	Post.	Ant.	Index	Post.	Ant.	Index	Post.	Ant.	Index	Post.	Ant.	Index	Post.	Ant.	Index
To-At-1-6	373	373	45	42	22	3.6	44	43	21	3.6	29	25	116.0	30	25	120.0	30	27	111.1	28	28	100.0	28	29	96.5
To-At-1-7	—	—	44	44	20	3.6	44	45	21	3.7	29	—	—	29	26	111.5	28	26	107.7	28	26	107.7	26	27	96.3
To-At-1-9	—	—	—	—	—	—	—	—	—	—	—	—	—	27	25	108.0	30	26	115.4	27	—	—	27	25	108.0
To-At-1-10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26	26	100.0	—	—	—	—	—	—
To-At-1-10B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-12	—	—	46	47	20	3.8	46	49	22	3.9	25	24	104.2	27	24	112.5	26	—	—	26	—	—	26	27	96.3
To-At-1-21A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-29	381	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-31	—	—	41	44	22	3.6	42	46	23	3.7	—	—	—	—	—	—	—	—	—	—	—	—	25	30	83.3
To-At-1-34	—	—	42	45	21	3.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26	30	86.7
To-At-2-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-13C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-18	—	—	—	—	—	—	—	—	—	—	26	24	108.3	27	—	—	26	25	104.0	24	25	96.0	—	—	—
To-At-2-22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-22A	—	386	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-31	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26	24	108.3	25	24	104.2	24	24	100.0
To-At-2-35	—	—	41	42	19	3.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-42	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26	26	100.0	25	27	92.6	25	22	92.6
To-At-2-44	—	—	48	46	23	3.9	46	46	23	3.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

INDIVIDUAL MEASUREMENTS OF TONGAN FEMALE INFRACRANIAL REMAINS (1)

	CLAVICLE Length		HUMERUS Length		Min.hd.di.		Max.hd.di.		ULNA Length		RADIUS Length		Hd.di.		FEMUR Length		Hd.di.		R.Subtrochanteric diameter		Platymeric index
	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	A-P	Lat.	
To-At-1-11	—	140	325	321	39	39	42	42	—	—	—	—	—	24	—	—	44	—	28	31	90.3
To-At-1-13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26	34	76.5
To-At-1-19	—	—	—	322	—	38	—	39	256	—	—	—	20	—	458	461	44	45	26	31	83.9
To-At-2-1C	142	—	311	—	35	—	40	—	230	—	205	—	20	—	—	—	—	—	—	—	—
To-At-2-4	152	154	359	360	44	44	48	50	275	280	260	258	28	27	512	509	52	52	27	33	81.8
To-At-2-10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-16	—	—	297	—	—	—	41	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	46	46	23	35	65.7
To-At-2-21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24	31	77.4
To-At-2-25	131	128	—	—	—	39	—	36	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-27	—	—	342	—	45	—	49	—	—	—	—	—	—	—	—	—	—	—	31	35	88.6
To-At-2-27A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	419	41	42	24	32	75.0
To-At-2-30	—	—	—	—	39	42*	41	43*	263	258	—	230	—	21	423	—	44	—	25	32	78.1
To-At-2-34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-40A	137*	129	302	—	37	37	40	41	239	—	222	—	—	—	—	—	—	—	—	—	—

* An approximate value.

INDIVIDUAL MEASUREMENTS OF TONGAN FEMALE INFRACRANIAL REMAINS (2)

	FEMUR									TIBIA							
	L di. & index			R ½ di. & index			L ½ di. & index			Length		R di. & index			L di. & index		
	A-P	Lat.	Platymeric	Tran.	A-P	Pilastric	Tran.	A-P	Pilastric	R	L	Tran.	A-P	Platycnemic	Tran.	A-P	Platycnemic
To-At-1-11	—	—	—	—	—	—	25	25	100.0	—	—	27	34	79.4	26	34	76.5
To-At-1-13	23	31	74.9	24	30	125.0	23	28	121.7	—	—	—	—	—	—	—	—
To-At-1-19	28	30	93.3	27	29	107.4	27	28	103.7	—	380	26	36	72.2	26	36	72.2
To-At-2-1C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-4	26	33	98.8	28	31	110.7	28	30	107.1	412	419	22	39	56.4	23	40	57.5
To-At-2-10	—	—	—	—	—	—	—	—	—	—	—	28	38	73.7	—	—	—
To-At-2-16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-20	23	35	65.7	26	30	115.4	26	28	107.7	381	—	24	36	66.7	26	37	70.3
To-At-2-21	—	—	—	—	—	—	—	—	—	—	—	24	34	70.6	24	36	66.7
To-At-2-23	—	—	—	25	27	108.0	—	—	—	—	—	—	—	—	—	—	—
To-At-2-25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-27	—	—	—	29	34	117.2	29	34	117.2	394	—	29	40	72.5	—	—	—
To-At-2-27A	—	—	—	—	—	—	25	28	112.0	—	—	—	—	—	24	33	72.7
To-At-2-30	25	35	71.4	34	27	112.5	25	27	108.0	—	357	—	—	—	27	37	73.0
To-At-2-34	—	—	—	—	—	—	—	—	—	—	—	25	34	73.5	25	33	75.8
To-At-2-40A	—	—	—	—	—	—	27	32	118.5	—	—	—	—	—	—	—	—

INDIVIDUAL MEASUREMENTS OF TONGAN FEMALE INFRACRANIAL REMAINS (3)

	FIBULA		R PATELLA				L PATELLA				LUMBAR VERTEBRAE														
	Length										L1			L2			L3			L4			L5		
	R	L	Lg.	Wd.	Ht.	Mod.	Lg.	Wd.	Ht.	Mod.	Post.	Ant.	Index	Post.	Ant.	Index	Post.	Ant.	Index	Post.	Ant.	Index	Post.	Ant.	Index
To-At-1-11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-19	—	—	40	43	20	3.4	40	42	20	3.4	30	29	103.4	30	30	100.0	26	30	86.7	31	28	110.7	29	29	100.0
To-At-2-1C	—	—	—	—	—	—	—	—	—	—	28	24	116.7	28	28	100.0	27	27	100.0	25	28	89.3	25	26	96.2
To-At-2-4	347	399	49	49	21	4.0	49	49	21	4.0	30	27	111.1	30	28	107.1	29	27	107.4	28	28	100.0	26	29	89.7
To-At-2-10	—	—	44	42	20	3.5	42	42	21	3.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-16	—	—	—	—	—	—	—	—	—	—	26	25	104.0	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-20	—	—	38	40	20	3.3	39	40	20	3.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-21	—	—	37	40	20	3.2	36	40	19	3.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-23	—	—	—	—	—	—	39	40	20	3.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-26	—	—	—	—	—	—	—	—	—	—	26	24	108.3	27	26	103.8	26	24	108.3	25	25	100.0	24	27	88.9
To-At-2-27	—	—	—	—	—	—	44	46	21	3.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-27A	—	—	36	35	19	3.0	37	38	19	3.1	26	24	108.3	—	—	—	—	—	—	—	—	—	24	25	96.0
To-At-2-30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-40A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

MAXIMUM LENGTHS OF THE SUBADULT INFRACRANIAL REMAINS

	AGE	CLAVICLE		HUMERUS		ULNA		RADIUS		FEMUR		TIBIA		FIBULA		PATELLA					
																R			L		
		R	L	R	L	R	L	R	L	R	L	R	L	R	L	Ht.	Bd.	Th.	Ht.	Bd.	Th.
To-At-1-1B	9 mos.	—	61	—	—	—	—	—	—	—	—	98*	—	—	—	—	—	—	—	—	—
To-At-1-2	2-3 yrs.	—	—	—	89	—	—	—	—	—	—	92	91	88	87	—	—	—	—	—	—
To-At-1-3	2 yrs.	—	58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-5	0-6 mos.	—	—	—	70	—	67	—	—	81	81	72	72	69	70	—	—	—	—	—	—
To-At-1-16	0-6 mos.	—	—	—	66	—	61	—	—	75	75	66	67	64	—	—	—	—	—	—	—
To-At-1-17	0-8 mos.	—	63	—	—	94	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-29C	0-6 mos.	—	—	—	—	—	—	—	—	—	—	—	85	—	—	—	—	—	—	—	—
To-At-1-32	0-9 mos.	—	—	—	97	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-35	6 mos.	65	—	95	96	86	86	75	75	123	123	—	—	—	—	—	—	—	—	—	—
To-At-1-36	2 yrs.	65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
To-At-1-37	7-8 yrs.	—	—	—	—	—	—	—	—	—	—	—	177	—	—	—	—	—	—	—	—
To-At-2-1A	3 yrs.	—	76	143	142	128	—	—	—	194	—	—	—	—	—	—	—	—	—	—	—
To-At-2-2	0-6 mos.	42	—	61	—	58	—	51	51	69	—	61	61	—	—	—	—	—	—	—	—
To-At-2-7	1-2 yrs.	60	59	99	100	85	96	76	78	122	124	104	104	98	—	—	—	—	—	—	—
To-At-2-11	23 yrs.	120	118	265	255	272	215	206	201	375	—	—	—	—	—	—	—	—	—	—	—
To-At-2-17	0-1 yr.	—	—	—	—	—	91	—	81	—	—	—	—	—	—	—	—	—	—	—	—
To-At-2-19	22 yrs.	—	—	—	—	—	—	—	—	446	440	—	355	—	—	—	—	—	44	43	19

* Intrusive.

TABLE 1

INDIVIDUAL AGE-GROUP ASSIGNMENT OF IMMATURE TONGANS, TO-AT-1 AND TO-AT-2

	TO-AT-1	TO-AT-2
New born to 1 year	1- 1B	2- 1
	1- 5	2-14
	1- 8	2-17
	1-16	
	1-17	
	1-29C	
	1-32	
	1-35	
	1-38	
1- 4 years	1- 1A	2- 1A
	1- 2	(2- 1E)
	1- 3	2- 7
	(1- 4C)	2- 9
	1-18	
	1-25	
	1-29B	
	1-36	
4- 8 years	1-15	2- 3
	1-28	2-21B
	1-37	2-36
12-18 years	1-14	2- 1D
	1-30	(2- 1E)
		2-15
		2-39

TABLE 2

INDIVIDUAL AGE-GROUP ASSIGNMENT ACCORDING TO SEX OF MATURE TONGANS

	MALE		FEMALE		SEX ?	
Young adult	1-34	2- 6	1-23	2-11		
		2-19		2-16		
		2-31				
		2-33				
Middle aged	1- 6	2-13		2- 1C		
		2-13A		2- 4		
				2-24B		
Aged	1- 7	2-18		2-40A		
		2-41				
Adult (not old)	1- 9			2-25	1-19	
	1-10					
	1-20					
Adult (?)	1-12	(2- 1E)	1- 4A	2-20	1- 4B	(2- 1E)
	1-27	2- 5	1-11	2-21	1- 4C	2-10
	1-29A	2- 8	1-13	2-24A	1-13C	2-23
	1-31	2-13C	1-26	2-26	'1-19'	2-34
		2-22		2-27	1-21A	2-35
		2-22A		2-27A	1-21B	2-37
		2-38		2-28		2-40B
		2-42		2-30		
				2-32		

TABLE 3

SUMMARY OF SUBADULT AND ADULT AGE-GROUPS PRESENT IN 'ATELE MOUNDS WITH REFERENCE TO SEX IF DETERMINED

	TO-AT-1		TO-AT-2		TOTAL	
	Number	%	Number	%	Number	%
Subadult (in years)						
0- 1	9	37.5	3	21.4	12	31.6
1- 4	8	33.3	4	28.6	12	31.6
4- 8	4	16.7	3	21.4	7	18.4
8-12						
12-18	2	8.3	4	28.6	6	15.8
18-22	1	4.2			1	2.6
Total	24	100.0	14	100.0	38	100.0
Adult						
Young males	1	50.0	4	66.7	5	62.5
„ females	1	50.0	2	33.3	3	37.5
Total	2	100.0	6	100.0	8	100.0
Young and/or middle-aged males	3	75.0			3	60.0
„ „ „ females			1	100.0	1	20.0
Sex ?	1	25.0			1	20.0
Total	4	100.0	1	100.0	5	100.0
Middle-aged males	1	100.0	2	40.0	3	50.0
„ females			3	60.0	3	50.0
Total	1	100.0	5	100.0	6	100.0
Aged males	1	100.0	2	66.7	3	75.0
„ females			1	33.3	1	25.0
Total	1	100.0	3	100.0	4	100.0
Adult (?) males	4	28.6	8	33.3	12	31.6
„ „ females	4	28.6	9	37.5	13	34.2
Sex (?)	6	42.8	7	29.2	13	34.2
Total	14	100.0	24	100.0	38	100.0
Total adult	22		39		61	
Total adult + subadult	46		53		99	
Percentage of adults		47.8		73.6		61.6
Percentage of subadults		52.2		26.4		38.4

TABLE 4

FREQUENCY OF MATURE TONGANS ACCORDING TO SEX

	TO-AT-1		TO-AT-2		TOTAL	
	N	%	N	%	N	%
Males	10	45.5	16	41.0	26	42.6
Females	5	22.7	16	41.0	21	34.4
Unknown	7	31.8	7	18.0	14	23.0
Total	22	100.0	39	100.0	61	100.0

TABLE 5

CRANIAL VARIATION 1. FACIAL MORPHOLOGY

TRAIT VARIATION	MALE/FEMALE				TO-AT-1/TO-AT-2				TOTAL		
		n	N	*%		*n*	N	%	*n*	N	%
Metopic suture											
Presence	M	11	0	0.0	I	6	0	0.0	24	0	0.0
	F	10	0	0.0	II	14	0	0.0			
Persistent on brow only	M	—	7	63.6		—	5	83.3	—	15	62.5
	F	—	5	50.0		—	6	42.9			
Frontal bossing											
Median	M	11	1	9.0	I	6	2	33.3	23	5	21.7
	F	9	2	22.2	II	14	2	14.3			
Bilateral	M	—	6	54.5		—	3	50.0	—	14	60.9
	F	—	7	77.7		—	9	64.3			
Frontal grooves											
Per skull	M	10	1	10.0	I	5	0	0.0	24	1	4.2
	F	10	0	0.0	II	15	1	6.7			
R side only	M	11	1	9.1		4	0	0.0	23	1	4.3
	F	10	0	0.0		15	1	6.7			
L side only	M	10	1	10.0		5	0	0.0	23	1	4.3
	F	10	0	0.0		14	1	7.1			
**RL (per side)	M	21	2	9.5		9	0	0.0	46	2	4.3
	F	20	0	0.0		29	2	6.9			
Right supraorbital											
Foramen	M	13	4	30.8	I	8	2	25.0	26	8	30.8
	F	10	3	30.0	II	14	5	35.7			
Notch	M	—	3	23.1		—	2	25.0	—	3	11.5
	F	—	0	0.0		—	1	7.1			
Spurred notch	M	—	6	46.2		—	4	50.0	—	15	57.7
	F	—	7	70.0		—	8	57.1			
Left supraorbital											
Foramen	M	10	3	30.0	I	6	1	16.7	20	5	25.0
	F	7	2	28.6	II	11	3	27.3			
Notch	M	—	1	10.0		—	0	0.0	—	2	20.0
	F	—	1	14.3		—	2	18.2			
Spurred notch	M	—	5	50.0		—	5	83.3	—	12	60.0
	F	—	4	57.1		—	5	45.5			
Double foramen	M	—	1	10.0		—	0	0.0	—	1	5.0
	F	—	0	0.0		—	1	9.1			
Brow ridge											
No	M	11	2	18.2	I	5	1	20.0	21	4	19.1
	F	8	0	0.0	II	12	3	25.0			
Disc +	M	—	0	0.0		—	1	20.0	—	0	0.0
	F	—	1	12.5		—	0	0.0			
+V	M	—	5	45.5		—	4	80.0	—	12	57.1
	F	—	0	0.0		—	4	33.3			
++V	M	—	4	36.4		—	0	0.0	—	5	23.8
	F	—	7	87.5		—	5	41.7			
Right infraorbital											
Two separate for.	M	4	3	75.0	I	1	1	100.0	7	6	85.7
	F	1	1	100.0	II	5	4	80.0			
Divided	M	—	1	25.0		—	0	0.0	—	1	14.3
	F	—	0	0.0		—	1	20.0			
Left infraorbital											
Two	M	3	2	66.7	I	1	1	100.0	7	6	85.7
	F	1	1	100.0	II	5	4	80.0			
Divided	M	—	1	33.3		—	0	0.0	—	1	14.3
	F	—	0	0.0		—	1	20.0			
Naso-frontal suture											
Angle	M	9	2	22.2	I	3	1	33.3	13	3	23.1
	F	3	1	33.3	II	9	2	22.2			
Omega	M	—	2	22.2		—	0	0.0	—	2	15.4
	F	—	0	0.0		—	1	11.1			
Fused laterally	M	—	5	55.6		—	2	66.7	—	8	61.5
	F	—	2	66.7		—	6	66.7			

TABLE 5—Continued

TRAIT VARIATION	MALE/FEMALE	n	N	*%	TO-AT-1/TO-AT-2	n	N	%	TOTAL n	N	%
Nasal bone shape											
Rectangular	M	2	0	0.0	I	0	—	—	3	0	0.0
	F	0	—	—	II	3	0	0.0			
Triangular	M	—	0	0.0		—	—	—	—	0	0.0
	F	—	—	—		—	0	0.0			
Hour glass shaped	M	—	2	100.0		—	—	—	—	3	100.0
	F	—	—	—		—	3	100.0			
Subnasal region											
Sharp	M	13	1	7.7	I	12	0	—	31	1	3.2
	F	10	0	0.0	II	12	0	—			
Blurred	M	—	11	84.6		—	8	66.7		23	74.2
	F	—	6	60.0		—	10	83.3			
Groove	M	—	0	0.0		—	0	—		1	3.2
	F	—	1	10.0		—	1	8.3			
Sulcus	M	—	1	7.7		—	4	33.3		6	19.4
	F	—	13	30.0		—	1	8.3			
Os Japonicum											
Per skull	M	7	0	0.0	I	3	0	0.0	15	0	0.0
	F	6	0	0.0	II	11	0	0.0			
R side	M	6	0	0.0		2	0	0.0	12	0	0.0
	F	4	0	0.0		9	0	0.0			
L side	M	5	0	0.0		3	0	0.0	12	0	0.0
	F	5	0	0.0		9	0	0.0			
RL (per side)	M	11	0	0.0		6	0	0.0	24	0	0.0
	F	9	0	0.0		18	0	0.0			
Right malar tuberosity											
+	M	8	2	25.0	I	4	0	0.0	16	3	18.8
	F	6	0	0.0	II	11	3	27.3			
++	M	—	0	0.0		—	0	0.0	—	0	0.0
	F	—	0	0.0		—	0	0.0			
+++	M	—	0	0.0		—	0	0.0	—	0	0.0
	F	—	0	0.0		—	0	0.0			
Left malar tuberosity											
+	M	6	1	16.7	I	4	0	0.0	13	2	15.4
	F	5	0	0.0	II	9	2	22.2			
++	M	—	0	0.0		—	0	0.0	—	0	0.0
	F	—	0	0.0		—	0	0.0			
+++	M	—	0	0.0		—	0	0.0	—	0	0.0
	F	—	0	0.0		—	0	0.0			
Right zygomaxillary tuberosity											
+	M	6	3	50.0	I	3	1	33.3	14	5	35.7
	F	6	2	33.3	II	10	4	40.0			
++	M	—	0	0.0		—	0	0.0	—	0	0.0
	F	—	0	0.0		—	0	0.0			
+++	M	—	0	0.0		—	0	0.0	—	0	0.0
	F	—	0	0.0		—	0	0.0			
Left zygomaxillary tuberosity											
+	M	5	3	60.0	I	3	2	66.7	12	5	41.7
	F	5	2	40.0	II	9	3	33.3			
++	M	—	1	20.0		—	0	0.0	—	1	8.3
	F	—	0	0.0		—	1	11.1			
+++	M	—	0	0.0		—	0	0.0	—	0	0.0
	F	—	0	0.0		—	0	0.0			

* Percentages should be viewed with caution owing to the smallness of the sample sizes.

** Actually 2*n*.

TABLE 6

CRANIAL VARIATION 2. BASAL MORPHOLOGY

TRAIT	VARIATION		MALE/FEMALE			TO-AT-1/TO-AT-2			TOTAL		
			n	N	%	*n*	N	%	*n*	N	%
Palatine torus											
	Presence	M	8	0	0.0	5	0	0.0	18	1	5.6
		F	5	0	0.0	9	1	11.1			
Palatine suture											
	Straight	M	5	0	0.0	4	0	0.0	9	0	0.0
		F	2	0	0.0	4	0	0.0			
	Ant. deflected	M	—	5	100.0	—	4	100.0	—	9	100.0
		F	—	2	100.0	—	4	100.0			
Right ovale-spinosum											
	Normal	M	6	6	100.0	4	4	100.0	7	7	100.0
		F	0	—	—	3	3	100.0			
Left ovale-spinosum											
	Normal	M	8	8	100.0	6	6	100.0	12	12	100.0
		F	2	2	100.0	6	6	100.0			
Precondylar											
	Facet	M	6	0	0.0	4	0	0.0	11	0	0.0
		F	3	0	0.0	5	0	0.0			
	Tuberosity	M	—	0	0.0	—	0	0.0	—	1	9.1
		F	—	1	33.3	—	1	20.0			
	Double tuberosity	M	—	1	16.7	—	1	25.0	—	1	9.1
		F	—	0	0.0	—	0	0.0			
Ossified apical											
	+	M	6	0	0.0	4	0	0.0	11	1	9.1
		F	3	1	33.3	5	1	20.0			
	++	M	—	1	16.7	—	1	25.0	—	1	9.1
		F	—	0	0.0	—	0	0.0			
	+++	M	—	0	0.0	—	0	0.0	—	0	0.0
		F	—	0	0.0	—	0	0.0			
Paramastoid											
	Per skull	M	9	4	44.4	5	3	60.0	11	5	45.5
		F	1	0	0.0	5	2	40.0			
	R side	M	6	3	50.0	2	2	100.0	5	4	80.0
		F	1	0	0.0	5	2	40.0			
	L side	M	8	3	37.5	4	2	50.0	6	4	66.7
		F	1	0	0.0	5	2	40.0			
	RL (per side)	M	14	6	42.9	6	4	66.7	11	8	72.7
		F	2	0	0.0	10	4	40.0			
Double ant. cond. canal											
	Per skull	M	11	3	27.3	7	3	42.9	21	4	19.1
		F	8	0	0.0	12	4	33.3			
	R side	M	7	1	14.3	5	0	0.0	18	1	5.6
		F	7	0	0.0	12	4	33.3			
	L side	M	10	2	20.0	7	3	42.9	19	3	15.8
		F	6	0	0.0	11	2	18.2			
	RL (per side)	M	17	2	11.8	12	3	25.0	37	4	10.8
		F	13	0	0.0	23	6	26.1			
Post. condylar canal											
	Per skull	M	10	7	70.0	5	3	60.0	16	9	56.3
		F	5	2	40.0	9	7	77.8			
	R side	M	8	4	50.0	3	2	66.7	12	6	50.0
		F	3	1	33.3	8	4	50.0			
	L side	M	8	5	62.5	4	2	50.0	14	9	64.3
		F	5	3	60.0	8	6	75.0			
	RL (per side)	M	16	9	56.3	7	4	57.1	26	15	57.7
		F	8	4	50.0	16	10	62.5			

TABLE 6—Continued

TRAIT	VARIATION	MALE/FEMALE				TO-AT-1/TO-AT-2			TOTAL		
			n	N	%	*n*	N	%	*n*	N	%
Occipital condyles											
	R1L1	M	10	6	60.0	6	4	66.7	20	12	60.0
		F	8	4	50.0	12	6	50.0			
	R2L2	M	—	1	10.0	—	0	0.0	—	1	5.0
		F	—	0	0.0	—	1	8.3			
	R1L2	M	—	1	10.0	—	1	16.7	—	1	5.0
		F	—	0	0.0	—	0	0.0			
	R1	M	—	1	10.0	—	0	0.0	—	2	10.0
		F	—	1	12.5	—	2	16.7			
	R2	M	—	0	0.0	—	0	0.0	—	2	10.0
		F	—	2	25.0	—	2	16.7			
	L1	M	—	1	10.0	—	1	16.7	—	0	0.0
		F	—	0	0.0	—	1	8.3			
	L2	M	—	0	0.0	—	0	0.0	—	2	10.0
		F	—	1	12.5	—	0	0.0			
Condylar arthritis											
	Per skull	M	3	2	66.7	4	4	100.0	17	10	58.8
		F	8	2	25.0	11	5	45.5			
	R side	M	2	1	50.0	3	3	100.0	15	9	60.0
		F	7	2	28.6	10	5	50.0			
	L side	M	3	1	33.3	4	4	100.0	15	10	66.7
		F	6	2	33.3	9	4	44.4			
	RL (per side)	M	5	2	40.0	7	7	100.0	33	19	57.6
		F	13	4	30.8	19	9	47.4			
INTERIOR											
Lateral sinus											
	To right	M	11	9	82.0	7	6	85.7	23	19	82.6
		F	9	7	77.8	12	10	83.3			
	To left	M	—	1	9.1	—	0	0.0	—	1	4.3
		F	—	0	0.0	—	1	8.3			
	Common	M	—	1	9.1	—	1	14.3	—	3	13.0
		F	—	2	22.2	—	1	8.3			

TABLE 7

CRANIAL VARIATION 3. MORPHOLOGY OF THE VAULT REGION

TRAIT	VARIATION		MALE/FEMALE			TO-AT-1/TO-AT-2			TOTAL		
			n	N	%	*n*	N	%	*n*	N	%
Coronal wormians											
	Presence	M	11	0	0.0	6	0	0.0	22	0	0.0
		F	8	0	0.0	12	0	0.0			
Sagittal wormians											
	Presence	M	10	0	0.0	5	0	0.0	21	0	0.0
		F	9	0	0.0	12	0	0.0			
Bregmatic bone											
	Presence	M	11	0	0.0	3	0	0.0	21	0	0.0
		F	8	0	0.0	13	0	0.0			
Lambdoid wormians											
	1	M	12	1	8.3	2	1	50.0	23	1	4.3
		F	11	0	0.0	14	0	0.0			
	2	M	—	0	0.0	—	0	0.0	—	0	0.0
		F	—	0	0.0	—	0	0.0			
	3	M	—	0	0.0	—	1	50.0	—	3	13.0
		F	—	2	18.2	—	1	7.1			
	+	M	—	3	25.0	—	0	0.0	—	5	21.7
		F	—	2	18.2	—	3	21.4			
At Lambda											
	Os Inca	M	12	1	8.3	4	0	0.0	23	1	4.3
		F	9	0	0.0	14	1	7.1			
	Trace	M	—	1	8.3	—	0	0.0	—	1	4.3
		F	—	0	0.0	—	0	0.0			
	Lambdic bone	M	—	0	0.0	—	0	0.0	—	0	0.0
		F	—	0	0.0	—	0	0.0			
	Bulge	M	—	2	16.6	—	0	0.0	—	2	8.7
		F	—	0	0.0	—	1	7.1			
Sagittal keel											
	+	M	11	7	63.6	5	4	80.0	22	17	77.3
		F	8	7	87.5	13	9	69.2			
	++	M	—	1	9.1	—	0	0.0	—	1	4.5
		F	—	0	0.0	—	1	7.7			
	+++	M	—	0	0.0	—	0	0.0	—	0	0.0
		F	—	0	0.0	—	0	0.0			
Parietal bossing											
	+	M	12	3	25.0	8	1	12.5	24	7	29.2
		F	9	4	44.4	12	4	33.3			
	++	M	—	9	75.0	—	7	87.5	—	17	70.8
		F	—	5	55.6	—	8	66.7			
	+++	M	—	0	0.0	—	0	0.0	—	0	0.0
		F	—	0	0.0	—	0	0.0			
R Parietal foramen											
	One	M	11	7	63.6	7	4	57.1	23	16	69.6
		F	9	6	66.7	12	9	75.0			
L Parietal foramen											
	One	M	13	9	69.2	9	6	66.7	26	17	65.4
		F	10	6	60.0	12	8	66.7			

TABLE 8

CRANIAL VARIATION 4. LATERAL ASPECT

TRAIT VARIATION		MALE/FEMALE n	N	%	TO-AT-1/TO-AT-2 n	N	%	TOTAL n	N	%
Marginal tuberosity										
Right	M	7	0	0.0	1	0	0.0	17	0	0.0
	F	9	0	0.0	11	0	0.0			
Left	M	5	0	0.0	2	0	0.0	13	0	0.0
	F	6	0	0.0	11	0	0.0			
Pterion (discrete)										
Right	M	2	0	0.0	1	0	0.0	4	0	0.0
	F	1	0	0.0	3	0	0.0			
Left	M	4	0	0.0	2	0	0.0	8	0	0.0
	F	3	0	0.0	5	0	0.0			
R Parietal notch										
	M	9	5	55.6	4	1	25.0	17	10	58.8
	F	6	4	66.7	11	7	63.6			
L Parietal notch										
Presence	M	8	4	50.0	3	2	66.7	17	11	64.7
	F	8	6	75.0	10	6	60.0			
Bone	M	—	1	12.5	—	0	0.0	—	1	5.9
	F	—	0	0.0	—	1	10.0			
Asterionic										
Per skull	M	8	2	25.0	4	1	25.0	16	5	31.3
	F	6	2	33.3	8	2	25.0			
R side	M	8	1	12.5	3	0	0.0	14	3	21.4
	F	5	1	20.0	8	2	25.0			
L side	M	7	2	28.6	3	1	33.3	14	4	28.6
	F	5	1	20.0	7	2	28.6			
RL (per side)	M	15	3	20.0	6	1	16.7	28	7	25.0
	F	10	2	20.0	15	4	26.7			
Occiput form										
Mound (M)	M	14	3	21.4	9	0	0.0	26	4	15.4
	F	9	1	11.1	13	3	23.1			
Ridge (R)	M	—	3	21.4	—	1	11.1	—	6	23.1
	F	—	3	33.3	—	4	30.8			
M-R	M	—	0	0.0	—	2	22.2	—	3	11.5
	F	—	1	11.1	—	1	7.7			
R-inion	M	—	8	57.1	—	6	66.7	—	13	50.0
	F	—	4	44.4	—	5	38.5			
Mastoid notch										
Per skull	M	12	4	33.3	7	3	42.9	28	9	32.1
	F	13	3	23.1	16	4	25.0			
R side	M	12	4	33.3	7	3	42.9	26	9	34.6
	F	11	3	27.3	15	4	26.7			
L side	M	11	4	36.4	6	2	33.3	25	7	28.0
	F	12	2	16.7	14	4	28.6			
RL (per side)	M	23	8	34.8	13	6	46.2	51	16	31.4
	F	23	5	21.7	29	8	27.6			
Mastoid size										
Small	M	11	0	0.0	9	2	22.2	24	5	20.8
	F	11	5	45.5	14	3	21.4			
Medium	M	—	0	0.0	—	0	0.0	—	0	0.0
	F	—	0	0.0	—	0	0.0			
Large	M	—	1	9.1	—	0	0.0	—	2	8.3
	F	—	1	9.1	—	2	14.3			
Small pendulant	M	—	0	0.0	—	0	0.0	—	3	12.5
	F	—	3	27.3	—	2	14.3			
Medium pendulant	M	—	4	36.4	—	3	33.3	—	7	29.2
	F	—	2	18.2	—	4	28.6			
Large pendulant	M	—	6	54.5	—	4	44.4	—	7	29.2
	F	—	0	0.0	—	3	21.4			

TABLE 8—Continued

TRAIT	VARIATION		MALE/FEMALE *n*	N	%	TO-AT-1/TO-AT-2 *n*	N	%	TOTAL *n*	N	%
Tympanic thickening											
	Per skull	M	18	8	44.4	8	2	25.0	28	4	14.3
		F	12	1	8.3	15	2	13.3			
	R side	M	18	8	44.4	8	2	25.0	26	4	15.4
		F	10	1	10.0	14	2	14.3			
	L side	M	13	3	23.1	7	2	28.6	27	4	14.8
		F	12	1	8.3	15	2	13.3			
	RL (per side)	M	31	11	35.5	15	4	26.7	53	8	15.1
		F	22	2	9.1	29	4	13.8			
Tympanic hole											
	Per skull	M	11	1	9.1	6	0	0.0	26	2	7.7
		F	12	1	8.3	14	2	14.3			
	R side	M	11	1	9.1	6	0	0.0	24	2	8.3
		F	10	1	10.0	13	2	15.4			
	L side	M	11	1	9.1	5	0	0.0	25	1	4.0
		F	12	0	0.0	14	1	7.1			
	RL (per side)	M	22	2	9.1	11	0	0.0	49	3	6.1
		F	22	1	4.5	27	3	11.1			
Tympanic exostoses											
	Per skull	M	11	5	45.5	7	3	42.9	27	11	40.7
		F	13	4	30.8	15	5	33.3			
	R side	M	11	5	45.5	7	3	42.9	25	10	40.0
		F	11	3	27.3	14	4	28.6			
	L side	M	11	3	27.3	6	2	33.3	26	9	34.6
		F	13	4	30.8	15	4	26.7			
	RL (per side)	M	22	8	36.4	13	5	38.5	51	19	37.3
		F	24	7	29.2	29	8	27.6			
Glenoid arthritis											
	Per skull	M	13	4	30.8	7	2	28.6	27	5	18.5
		F	11	1	9.1	16	3	18.8			
	R side	M	13	4	30.8	7	2	28.6	25	5	20.0
		F	9	1	11.1	13	3	23.1			
	L side	M	13	2	15.4	6	0	0.0	23	3	13.1
		F	8	1	12.5	13	3	23.1			
	RL (per side)	M	26	6	23.1	13	2	15.4	48	8	16.7
		F	17	2	11.8	28	6	21.4			

TABLE 9

CRANIAL VARIATION 5. MORPHOLOGY OF THE MANDIBLE

TRAIT	VARIATION		MALE/FEMALE			TO-AT-1/TO-AT-2			TOTAL		
			n	N	%	*n*	N	%	*n*	N	%
Chin form											
	Median (M)	M	17	1	5.9	10	1	10.0	31	7	22.6
		F	12	6	50.0	18	4	22.2			
	Bilateral (B)	M	—	3	17.7	—	2	20.0	—	6	19.4
		F	—	1	8.3	—	4	22.2			
	M-B	M	—	3	17.7	—	0	0.0	—	4	12.9
		F	—	0	0.0	—	3	16.7			
	M-Angular	M	—	2	11.8	—	1	10.0	—	4	12.9
		F	—	2	26.7	—	3	16.7			
	B-A	M	—	3	17.7	—	2	20.0	—	5	16.1
		F	—	2	16.7	—	4	22.2			
	MBA	M	—	5	29.4	—	4	40.0	—	5	16.1
		F	—	1	8.3	—	0	0.0			
Mandibular torus		M	18	0	0.0	12	0	0.0	35	2	5.7
		F	12	1	8.3	19	2	10.5			
Gonial eversion-inversion											
	+	M	18	4	22.2	12	2	16.7	31	6	19.4
		F	9	1	11.1	16	3	18.8			
	++	M	—	3	16.7	—	3	25.0	—	4	12.9
		F	—	1	11.1	—	1	6.3			
	+ Inv.	M	—	0	0.0	—	3	25.0	—	5	16.1
		F	—	1	11.1	—	1	6.3			
	Inv. ++	M	—	0	0.0	—	1	8.3	—	4	12.9
		F	—	0	0.0	—	3	18.8			
R Mylo-hyoid bridge											
	Arch	M	18	0	0.0	12	0	0.0	31	0	0.0
		F	9	0	0.0	14	0	0.0			
	Distal	M	—	2	11.1	—	1	8.3	—	2	6.5
		F	—	0	0.0	—	0	0.0			
	A-D	M	—	1	5.6	—	1	8.3	—	1	3.2
		F	—	0	0.0	—	0	0.0			
L Mylo-hyoid bridging											
	Distal	M	18	1	5.6	12	0	0.0	33	1	3.0
		F	10	0	0.0	17	0	0.0			
	A-D	M	—	1	5.6	—	1	8.3	—	1	3.0
		F	—	0	0.0	—	0	0.0			
	Incipient bridge	M	—	0	0.0	—	0	0.0	—	1	3.0
		F	—	1	10.0	—	1	5.9			
Multiple mandibular foramina											
	Per skull	M	18	1	5.6	12	0	0.0	34	1	2.9
		F	11	0	0.0	19	2	10.5			
	R side	M	18	0	0.0	12	0	0.0	31	0	0.0
		F	9	0	0.0	17	0	0.0			
	L side	M	17	1	5.9	11	0	0.0	32	1	2.9
		F	10	0	0.0	18	2	11.1			
	RL (per side)	M	35	1	2.9	23	0	0.0	63	1	1.6
		F	19	0	0.0	35	2	5.7			
Multiple mental foramina											
	Per skull	M	18	3	16.7	12	1	8.3	35	6	17.1
		F	12	2	16.7	19	5	26.3			
	R side	M	18	1	5.6	12	0	0.0	33	3	9.1
		F	11	2	18.2	18	3	16.7			
	L side	M	18	2	11.1	12	1	8.3	34	3	8.8
		F	11	0	0.0	18	2	11.1			
	RL (per side)	M	36	3	8.3	24	1	4.2	67	6	9.0
		F	22	2	9.1	36	5	13.9			

TABLE 9—Continued

TRAIT	VARIATION		MALE/FEMALE			TO-AT-1/TO-AT-2			TOTAL		
			n	N	%	*n*	N	%	*n*	N	%
Condylar arthritis											
	Per skull	M	16	3	18.8	11	0	0.0	26	5	19.2
		F	7	2	28.6	13	4	30.8			
	R side	M	12	3	25.0	9	0	0.0	20	4	20.0
		F	6	1	16.7	9	2	22.2			
	L side	M	12	0	0.0	9	0	0.0	21	2	9.5
		F	6	2	33.3	10	2	20.0			
	RL (per side)	M	24	3	12.5	18	0	0.0	41	6	14.6
		F	12	3	25.0	19	4	21.1			
Rocker jaw											
	Full	M	18	10	55.6	11	7	63.6	34	23	67.6
		F	12	7	58.3	19	13	68.4			
	Slight	M	—	1	5.6	—	0	0.0	—	3	8.8
		F	—	0	0.0	—	3	15.8			
Coronoid: condyle (Hd.) relationship											
	C = Hd.	M	12	5	41.7	4	2	50.0	23	13	56.5
		F	14	8	57.1	14	1	7.1			
	C > Hd. +	M	—	6	50.0	—	1	25.0	—	7	30.4
		F	—	4	28.6	—	4	28.6			
	C > Hd. ++	M	—	1	8.3	—	0	0.0	—	1	4.3
		F	—	1	7.1	—	1	7.1			
Coronoid < condyle		M	—	0	0.0	—	0	0.0	—	2	8.7
		F	—	1	7.1	—	1	7.1			

TABLE 10

CRANIAL VARIATION OF SUBADULT INDIVIDUALS

TRAIT	VARIATION	*n*	N	%
Metopic suture				
	Trace	6	1	16.7
	Persist. on brow	—	4	66.7
Frontal grooves				
	Per skull	2	0	0.0
R supraorbital				
	Single for.	4	4	100.0
L supraorbital				
	Spurred notch	2	2	100.0
R infraorbital				
	Single	3	3	100.0
L infraorbital				
	Single	5	5	100.0
Os Japonicum		2	0	0.0
R malar tuberosity				
	+	2	1	50.0
L malar tuberosity				
	+	1	1	100.0
R zygomaxillary tuberosity				
	+	8	6	75.0
	++	—	1	12.5
L zygomaxillary tuberosity				
	+	7	6	85.7
	++	—	1	14.3
Palatine torus		4	0	0.0
R ovale-spinosum				
	Normal	5	4	80.0
	Other	—	1	20.0
L ovale-spinosum				
	Normal	7	6	85.7
	Other	—	1	14.3
Precondylar tubercle		1	0	0.0
Ossified apical		1	0	0.0
Paramastoid				
	R+L—	1	1	100.0
Anterior condylar canal—doubling				
	Per skull	5	0	0.0
Posterior condylar canal				
	Per skull	2	1	50.0
Occipital condyles				
	R1L1	1	1	100.0
Lateral sinus				
	Right	6	4	66.7
	Left	—	2	33.3
Coronal wormians		2	0	0.0
Sagittal wormians		1	0	0.0
Bregmatic bone		2	0	0.0

TRAIT	VARIATION	*n*	N	%
Lambdoid wormians		1	0	0.0
At Lambda		1	0	0.0
Sagittal keel				
	+	1	1	100.0
Parietal bossing				
	+	3	1	33.3
	++	—	1	33.3
R parietal foramen				
	Single	3	1	33.3
L parietal foramen				
	Single	3	1	33.3
R marginal tuberosity		2	0	0.0
L marginal tuberosity		2	0	0.0
R pterion				
	H	1	1	100.0
L pterion				
	H	1	1	100.0
R parietal notch		1	0	0.0
L parietal notch		1	0	0.0
Asterionic		1	0	0.0
Occiput form				
	Ridge	2	1	50.0
	R-inion	—	1	50.0
Mastoid notch				
	Per skull	3	0	0.0
Tympanic thickening		4	0	0.0
Tympanic dehiscence		4	0	0.0
Tympanic exostoses				
	Per skull	8	2	25.0
Chin form				
	Median	6	3	50.0
	Bilateral	—	3	50.0
Mandibular torus		11	0	0.0
Gonial eversion				
	+	4	1	25.0
	Inv. +	—	1	25.0
R mylo-hyoid bridge		10	0	0.0
L mylo-hyoid bridge		11	0	0.0
Multiple mandibular foramina				
	Per skull	13	2	15.4
Multiple mental foramina				
	Per skull	18	3	16.7
	R side	—	3	16.7
	L side	—	1	
	RL (per side)	—	4	22.2
Rocker jaw				
	Full	6	4	66.7
	Slight	—	1	16.7

TABLE 11

SELECTED GROUPED ADULT AND SUBADULT CRANIAL VARIATIONS

TRAIT	VARIATION	*n*	N	%
Metopic suture				
	Brow only	29	19	65.5
Frontal grooves				
	Per skull	26	1	3.8
R supraorbital				
	Foramen	30	12	40.0
	Notch	—	3	10.0
	Spurred notch	—	15	50.0
L supraorbital				
	Foramen	22	5	22.7
	Notch	—	2	9.1
	Spurred notch	—	12	54.5
	Double for.	—	1	4.5
R infraorbital				
	Single	10	3	30.0
	Two separate	—	6	60.0
	Two divided	—	1	10.0
L infraorbital				
	Single	12	5	41.7
	Two separate	—	6	50.0
	Two divided	—	1	8.3
Os Japonicum		17	0	0.0
R malar tuberosity				
	+	18	3	16.7
	++	—	0	0.0
	+++	—	0	0.0
L malar tuberosity				
	+	14	3	21.4
	++	—	0	0.0
	+++	—	0	0.0
R zygomaxillary tuberosity				
	+	24	11	45.8
	++	—	2	8.3
	+++	—	0	0.0
L zygomaxillary tuberosity				
	+	19	11	57.9
	++	—	2	10.5
	+++	—	0	0.0
Palatine torus		22	1	4.5
Anterior condylar canal doubled				
	Per skull	26	4	15.4
Posterior condylar canal		18	10	55.6
Occipital condyles				
	R1L1	21	13	61.9
	R2L2	—	1	4.8
	R1L2	—	1	4.8
	R1	—	2	9.5
	R2	—	2	9.5
	L1	—	0	0.0
	L2	—	2	9.5
Lateral sinus				
	Right	29	23	79.3
	Left	—	3	10.3
	Common	—	3	10.3
Coronal wormians		24	0	0.0
Sagittal wormians		22	0	0.0
Bregmatic bone		23	0	0.0
Lambdoid wormian				
	One	24	1	4.2
	Two	—	0	0.0
	Three	—	3	12.5
	3+	—	5	20.8
At Lambda				
	Os Inca	24	1	4.2
	Trace	—	1	4.2
	Lambdic bone	—	0	0.0
	Bulge	—	2	8.3
R parietal foramen				
	Single	26	17	65.4
L parietal foramen		29	20	69.0
R parietal notch		18	10	55.6
L parietal notch				
	Notch	18	11	61.1
	Bone	—	1	5.6
Asterionic		17	5	29.4
Mastoid notch		31	9	29.0
Auditory exostoses		29	13	44.8
Mandibular torus		46	2	4.3
R mylo-hyoid bridge				
	Distal	41	2	4.9
	A-D	—	1	2.4
L mylo-hyoid bridge				
	Distal	41	1	2.3
	A-D	—	1	2.3
	Incipient bridge	—	1	2.3
Multiple mandibular foramina				
	Per skull	47	3	6.4
Multiple mental foramina				
	Per skull	53	9	17.0
Rocker jaw				
	Full	40	27	67.5
	Slight	—	4	10.0
Paramastoid				
	Per skull	12	6	50.0
	R side	6	5	83.3
	L side	7	4	57.1
	RL (per side)	13	9	69.2

TABLE 12

CRANIOMETRY

Measurement	MALE n	Range	Mean	S.D.	FEMALE n	Range	Mean	S.D.
Cranial length	13	174 - 196	183.1	7.9	5	170 - 181	172.6	4.2
Cranial breadth	12	130 - 170	143.0	10.0	4	123 - 143	133.5	7.4
Cranial height	6	140 - 155	144.8	5.2	2	138 - 144	141.0	3.0
Cranial capacity	6	1371.8-1710.5	1514.2	119.7	2	1262.2-1361.3	1311.7	49.6
Cranial module	6	148.3- 165.7	157.1	5.8	2	143.7- 152.7	148.2	4.5
Cranial index	11	72.4- 91.4	78.3	6.2	4	72.4- 83.6	77.1	4.1
Length-height index	6	75.8- 84.5	80.4	2.7	2	81.2- 84.2	82.7	1.5
Breadth-height index	6	82.9- 110.7	99.8	9.1	2	100.7- 112.2	106.4	5.8
Basion-nasion	5	106 - 111	108.6	1.7	2	101 - 110	105.5	4.5
Basion-prosthion	3	99 - 108	103.7	3.7	0	——	—	—
Gnathic index	3	93.4- 98.2	96.0	2.0	0	——	—	—
Min. frontal breadth	12	89 - 112	101.8	6.4	5	90 - 103	97.6	4.8
Bizygomatic diam.	3	140 - 145	142.7	2.1	0	——	—	—
Upper facial height	3	65 - 75	68.7	4.5	0	——	—	—
Upper facial index	3	45.5- 51.7	48.1	2.6	0	——	—	—
Total facial height	2	113 - 120	116.5	3.5	0	——	—	—
Total facial index	2	79.0- 85.7	82.4	3.3	0	——	—	—
Orbital breadth	3	45 - 47	46.0	0.8	0	——	—	—
Orbital height	3	32 - 39	35.7	2.9	0	——	—	—
Orbital index	3	69.6- 83.0	77.5	5.8	0	——	—	—
Nasal breadth	3	28 - 29	28.3	0.5	0	——	—	—
Nasal height	3	51 - 62	55.3	4.8	0	——	—	—
Nasal index	3	45.2- 56.9	51.6	4.9	0	——	—	—
Alveolar breadth	5	62 - 68	64.8	2.7	2	55 - 66	60.5	5.5
Alveolar height	4	42 - 63	58.3	4.0	1	55	55	0.0
Alveolar index	4	105.0- 128.3	113.0	9.1	1	120.0	120.0	0.0
Bigonial diameter	17	88 - 115	101.3	8.5	7	92 - 101	95.3	2.9
Symphysis height	18	24 - 35	30.3	3.1	10	26 - 34	29.5	2.3
Ramus height	18	51 - 75	61.3	7.1	9	45 - 68*	59.7	7.0
Ramus breadth	18	30 - 46	37.6	3.8	10	33 - 42	36.2	2.9
Mandibular length	14	101 - 116	109.1	4.7	7	90 - 118	106.4	8.5
Bicondylar width	14	114 - 138	126.4	7.7	4	109 - 132	121.0	8.2

* An approximate value having the same meaning throughout this report when used in association with metrical values.

TABLE 13

FREQUENCY OF OCCURRENCE OF MANDIBULAR MOLAR FISSURE PATTERNS ACCORDING TO SEX

Fissure pattern		M1							M2							M3						
		R			L				R			L				R			L			
		M.	F.	?	M.	F	?	Grand Total	M.	F.	?	M.	F	?	Grand Total	M.	F.	?	M.	F	?	Grand Total
	n	7	5	4	9	5	4	34	9	6	6	11	6	5	43	8	6	4	7	6	3	34
+4	N.	0	1	0	0	0	0	1	6	4	5	8	5	3	31	1	3	0	0	0	0	4
	%	—	20.0	—	—	—	—	2.9	66.7	66.7	83.3	72.7	83.3	60.0	72.1	12.5	50.0	—	—	—	—	11.8
+5	N.	7	4	2	4	2	3	22	3	1	0	3	0	2	9	3	1	1	6	5	2	18
	%	100.0	80.0	50.0	44.4	40.0	75.0	64.7	33.3	16.7		27.3		40.0	20.9	37.5	16.7	25.0	85.7	83.3	66.7	52.9
Y5	N.	0	0	0	5	3	1	9	0	0	1	0	0	0	1	1	0	0	0	0	0	1
	%	—	—	—	55.6	60.0	25.0	26.5	—	—	16.7	—	—	—	2.3	12.5	—	—	—	—	—	2.9
Y4	N.	0	0	1	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	1
	%	—	—	25.0	—	—	—	2.9	—	16.7	—	—	—	—	2.3	12.5	—	—	—	—	—	2.9
Crenulated +5	N.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	3
	%	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16.7	25.0	—	—	33.3	8.8
Wrinkled	N.	0	0	1	0	0	0	1	0	0	0	0	1	0	1	2	1	2	1	1	0	7
	%	—	—	25.0	—	—	—	2.9	—	—	—	—	16.7	—	2.3	25.0	16.7	50.0	14.3	16.7	—	20.6

TABLE 14

FREQUENCY OF OCCURRENCE OF SHOVEL-SHAPED INCISORS (MAXILLARY)

DEGREE		CENTRAL INCISOR									LATERAL INCISOR									GRAND TOTAL
		R			L			T			R			L			T			
		M.	F.	?	M.	F.	?	M.	F.	?	M.	F.	?	M.	F.	?	M.	F.	?	
	n	5	5	4	6	3	3	11	8	7	8	5	8	10	5	5	18	10	13	87
No shovel	N.	4	2	3	5	0	2	9	2	5	6	3	7	8	2	3	14	5	10	45
	%	80.0	40.0	75.0	83.3	—	66.7	81.8	25.0	71.4	75.0	60.0	87.5	80.0	40.0	60.0	77.8	50.0	76.9	51.7
Slight shovel	N.	0	1	0	0	1	1	0	2	1	1	0	0	1	2	1	2	2	1	8
	%	—	20.0	—	—	33.3	33.3	—	25.0	14.3	12.5	—	—	10.0	40.0	20.0	11.1	20.0	7.7	9.2
Shovel	N.	1	2	1	1	2	0	2	4	1	1	2	1	1	1	1	2	3	2	14
	%	20.0	40.0	25.0	16.7	66.7	—	18.2	50.0	14.3	12.5	40.0	12.5	10.0	20.0	20.0	11.1	30.0	15.4	16.1
All kinds of shovelling	N.	1	3	1	1	3	1	2	6	2	2	2	1	2	3	2	4	5	3	22
	%	20.0	60.0	25.0	16.7	100.0	33.3	18.2	75.0	28.6	25.0	40.0	12.5	20.0	60.0	40.0	22.2	50.0	23.1	25.3

TABLE 15

THE INCIDENCE OF PREMORTEM AND POSTMORTEM TOOTH LOSS

TOOTH GROUP	n	NUMBER		INCIDENCE	
		POSTMORTEM	PREMORTEM	POSTMORTEM %	PREMORTEM %
Upper molar	174	16	13	9.2	7.5
Lower molar	221	16	46	7.2	20.8
Total	395	32	59	8.1	14.9
Upper premolar	124	17	8	13.7	6.5
Lower premolar	152	25	5	16.4	3.3
Total	276	42	13	15.2	4.7
Upper canine	63	19	4	30.2	6.3
Lower canine	73	18	4	24.7	5.5
Total	136	37	8	27.2	5.9
Upper incisor	124	50	6	40.3	4.8
Lower incisor	150	59	8	39.3	5.3
Total	274	109	14	39.8	5.1
Upper total	485	102	31	21.0	6.4
Lower total	596	118	63	19.8	10.6
Grand total	1081	220	94	20.4	8.7

TABLE 16

FREQUENCY OF OCCURRENCE OF ATTRITION OF MAXILLARY DENTITIONS

TOOTH GROUP	DEGREE	NUMBER				PERCENTAGE			
		M	F	?	T	M	F	?	TOTAL
Ant. maxillary region	n	12	7	7	—	—	—	—	26
	None	2	1	1	4	16.7	14.3	14.3	15.4
	Slight	5	3	5	13	41.7	42.8	71.4	50.0
	Blunting	5	2	1	8	41.7	28.6	14.3	30.8
	Dentine exposed	0	1	0	1	0.0	14.3	0.0	3.8
	Pulp exposed	0	0	0	0	0.0	0.0	0.0	0.0
Post. maxillary region	n	11	7	8	—	—	—	—	26
	None	2	1	1	4	18.2	14.3	12.5	15.4
	Slight	4	3	5	12	36.4	42.8	62.5	46.2
	Blunting	5	2	1	8	45.5	28.6	12.5	30.8
	Dentine exposed	0	1	1	2	0.0	14.3	12.5	7.7
	Pulp exposed	0	0	0	0	0.0	0.0	0.0	0.0
General maxillary attrition	n	14	7	9	—	—	—	—	30
	None	2	1	1	4	14.3	14.3	11.1	13.3
	Slight	6	3	2	11	42.9	42.8	22.2	36.7
	Medium	5	2	4	11	35.7	28.6	44.4	36.7
	Marked	1	1	2	4	7.1	14.3	22.2	13.3

TABLE 17

FREQUENCY OF OCCURRENCE OF ATTRITION OF MANDIBULAR DENTITIONS

TOOTH GROUP	DEGREE		NUMBER M	NUMBER F	NUMBER ?	NUMBER T	PERCENTAGE M	PERCENTAGE F	PERCENTAGE ?	PERCENTAGE TOTAL
Ant. mandibular teeth		*n*	14	12	9	—	—	—	—	35
	None		1	1	1	3	7.1	8.3	11.1	8.6
	Slight		8	7	3	18	57.1	58.3	33.3	51.4
	Blunting		3	1	5	9	21.4	8.3	55.6	25.7
	Dentine exposed		2	3	0	5	14.3	25.0	0.0	14.3
	Pulp exposed		0	0	0	0	0.0	0.0	0.0	0.0
Post. mandibular teeth		*n*	14	12	8	—	—	—	—	34
	None		1	1	1	3	7.1	8.3	12.5	8.8
	Slight		7	4	2	13	50.0	33.3	25.0	38.2
	Blunting		4	1	5	10	28.5	8.3	62.5	29.4
	Dentine exposed		1	5	0	6	7.1	41.7	0.0	17.6
	Pulp exposed		1	1	0	2	7.1	8.3	0.0	5.9
General mandibular attrition		*n*	18	11	10	—	—	—	—	39
	None		1	1	2	4	5.5	9.1	20.0	10.3
	Slight		7	3	2	12	38.2	27.3	20.0	30.8
	Medium		6	3	5	14	33.3	27.3	50.0	35.9
	Marked		4	4	1	9	22.2	36.4	10.0	23.1

TABLE 18

INCIDENCE OF VARIOUS TYPES OF CARIES FOUND IN THE TOTAL ADULT SERIES

TOOTH GROUP (*n*)		BUCCAL NECK	LINGUAL NECK	INTERPROXIMAL NECK	DEEP OCCLUSAL	PIT	TOTAL
Upper molars	N	6	0	8	0	8	22
(165)	%	3.6	—	4.8	0	4.8	13.3
Upper premolars	N	1	0	0	1	1	3
(120)	%	0.8	—	—	0.8	0.8	2.5
Upper canine	N	1	0	2	2	1	6
(58)	%	1.7	—	3.4	3.4	1.7	10.3
Upper incisor	N	3	0	3	0	2	8
(101)	%	3.0	—	3.0	—	2.0	7.9
Total upper	N	11	0	13	3	12	39
(444)	%	2.5	—	2.9	0.7	2.7	8.8
Lower molars	N	8	2	5	1	13	29
(222)	%	3.6	0.9	2.3	0.5	5.9	13.1
Lower premolars	N	6	0	4	1	1	12
(151)	%	4.0	—	2.6	0.7	0.7	7.9
Lower canine	N	2	0	2	0	0	4
(73)	%	2.7	—	2.7	—	—	5.5
Lower incisor	N	0	0	2	0	0	2
(142)	%	—	—	1.4	—	—	1.4
Total lower	N	16	2	13	2	14	47
(588)	%	2.7	0.3	2.2	0.3	2.4	8.0
Grand total	N	27	2	26	5	26	86
(1032)	%	2.6	0.2	2.5	0.5	2.5	8.3

TABLE 19

THE INCIDENCE OF CARIES FOR THE TOTAL SERIES

TOOTH GROUP	*n*	NUMBER	PERCENTAGE
All molars	387	51	13.2
All premolars	271	15	5.5
All canines	131	10	7.6
All incisors	243	10	4.1
Total	1032	86	8.3

TABLE 20

FREQUENCY OF OCCURRENCE OF PERIODONTAL DISEASE

REGION	DEGREE		NUMBER				PERCENTAGE			
			M	F	?	TOTAL	M	F	?	TOTAL
Maxillary dentition										
Calculus build-up		*n*	14	5	9	—	—	—	—	28
	0		4	1	0	5	28.6	20.0	0.0	17.9
	+		5	0	5	10	35.7	0.0	55.6	35.7
	++		2	2	4	8	14.3	40.0	44.4	28.6
	+++		3	2	0	5	21.4	40.0	0.0	17.9
Alveolar recession		*n*	13	6	10	—	—	—	—	29
	0		2	1	2	5	15.4	16.7	20.0	17.2
	+		2	0	1	3	15.4	0.0	10.0	10.3
	++		4	3	7	14	30.8	50.0	70.0	48.3
	+++		5	2	0	7	38.5	33.3	0.0	24.1
Rolled rim		*n*	7	3	6	—	—	—	—	16
	0		5	1	3	9	71.4	33.3	50.0	56.2
	+		1	1	1	3	14.3	33.3	16.7	18.8
	++		0	1	1	2	0.0	33.3	16.7	12.5
	+++		1	0	1	2	14.3	0.0	16.7	12.5
Mandibular dentition										
Calculus build-up		*n*	17	12	10	—	—	—	—	39
	0		5	2	3	10	29.4	16.7	30.0	25.6
	+		5	5	4	14	29.4	41.7	40.0	35.9
	++		6	4	2	12	35.3	33.3	20.0	30.8
	+++		1	1	1	3	5.9	8.3	10.0	7.7
Alveolar recession		*n*	17	12	9	—	—	—	—	38
	0		2	3	1	6	11.8	25.0	11.1	15.8
	+		5	1	2	8	29.4	8.3	22.2	21.1
	++		6	5	6	17	35.3	41.7	66.7	44.7
	+++		4	3	0	7	23.5	25.0	0.0	18.4
Rolled rim		*n*	11	10	8	—	—	—	—	29
	0		5	2	4	11	45.5	20.0	50.0	37.9
	+		6	4	1	11	54.5	40.0	12.5	37.9
	++		0	4	3	7	0.0	40.0	37.5	24.1
	+++		0	0	0	0	0.0	0.0	0.0	0.0

TABLE 21

MORPHOLOGICAL VARIATION OF THE CERVICAL VERTEBRAE

AREA	VARIATION	SEX	RIGHT n	RIGHT N	LEFT n	LEFT N	RIGHT %	LEFT %	TOTAL (RL) n	TOTAL (RL) N	TOTAL (RL) %
C-1											
Superior articular facet											
	Single	M	11	9	13	10	81.9	76.9	24	19	79.2
		F	9	8	8	7	88.9	87.5	17	15	88.2
	Double	M	—	1	—	1	9.1	7.7	—	2	8.3
		F	—	0	—	0	0.0	0.0	—	0	0.0
	Constricted	M	—	1	—	2	9.1	15.4	—	3	12.5
		F	—	1	—	1	11.1	12.5	—	2	11.7
Foramen transversarium											
	Single	M	11	11	13	13	100.0	100.0	24	24	100.0
		F	8	8	8	8	100.0	100.0	16	16	100.0
R:L foramen transversarium											
	R > L	M							8	2	25.0
		F							4	3	75.0
	R < L	M							—	2	25.0
		F							—	0	0.0
	R = L	M							—	4	50.0
		F							—	1	25.0
Bridging, presence		M	11	0	13	0	0.0	0.0	24	0	0.0
		F	8	0	8	0	0.0	0.0	16	0	0.0
Posterior arch foramen											
	Presence	M	11	1	12	0	9.1	0.0	23	1	4.3
		F	8	1	8	1	12.5	12.5	16	2	12.5
C-2											
Ossified apical ligament											
	Presence	M							15	1	6.7
		F							8	1	12.5
Superior articular facet											
	Single	M	15	15	15	15	100.0	100.0	30	30	100.0
		F	5	5	6	6	100.0	100.0	11	11	100.0
Foramen transversarium											
	Single	M	15	15	15	15	100.0	100.0	30	30	100.0
		F	5	5	6	6	100.0	100.0	11	11	100.0
R:L foramen transversarium											
	R = L	M							13	8	61.5
		F							3	2	66.7
	R > L	M							—	3	23.1
		F							—	0	0.0
	R < L	M							—	2	15.4
		F							—	1	33.3
C-3											
Foramen transversarium											
	Single	M	12	12	11	11	100.0	100.0	23	23	100.0
		F	6	6	5	5	100.0	100.0	11	11	100.0
R:L foramen transversarium											
	R = L	M							6	4	66.7
		F							4	3	75.0
	R > L	M							—	1	16.7
		F							—	0	0.0
	R < L	M							—	1	16.7
		F							—	1	25.0
Superior articular surface											
	Single	M	13	13	12	12	100.0	100.0	25	25	100.0
		F	7	7	6	6	100.0	100.0	13	13	100.0
C-4											
Foramen transversarium											
	Single	M	10	10	13	13	100.0	100.0	23	23	100.0
		F	5	5	5	5	100.0	100.0	10	10	100.0

TABLE 21—Continued

AREA	VARIATION	SEX	RIGHT n	RIGHT N	LEFT n	LEFT N	RIGHT %	LEFT %	TOTAL (RL) n	TOTAL (RL) N	TOTAL (RL) %
R:L foramen transversarium											
	R = L	M							6	3	50.0
		F							3	2	66.7
	R > L	M							—	2	33.3
		F							—	0	0.0
	R < L	M							—	1	16.7
		F							—	1	33.3
Superior articular surface											
	Single	M	12	12	13	13	100.0	100.0	25	25	100.0
		F	9	9	9	9	100.0	100.0	18	18	100.0
C-5											
Foramen transversarium											
	Single	M	9	7	11	11	77.8	100.0	20	18	90.0
		F	5	5	6	5	100.0	83.3	11	10	90.9
	Double	M	—	1	—	0	11.1	0.0	—	1	5.0
		F	—	0	—	1	0.0	16.7	—	1	9.1
	Single + spur	M	—	1	—	0	11.1	0.0	—	1	5.0
		F	—	0	—	0	0.0	0.0	—	0	0.0
R:L foramen transversarium											
	R = L	M							5	1	20.0
		F							4	2	50.0
	R > L	M							—	2	40.0
		F							—	0	0.0
	R < L	M							—	2	40.0
		F							—	2	50.0
Superior articular surface											
	Single	M	10	10	11	11	100.0	100.0	21	21	100.0
		F	8	8	7	7	100.0	100.0	15	15	100.0
C-6											
Foramen transversarium											
	Single	M	9	6	8	6	66.7	75.0	17	12	70.6
		F	6	3	5	3	50.0	60.0	11	6	54.5
	Double	M	—	2	—	2	22.2	25.0	—	4	23.5
		F	—	3	—	2	50.0	40.0	—	5	45.5
	Spurred	M	—	1	—	0	11.1	0.0	—	1	5.9
		F	—	0	—	0	0.0	0.0	—	0	0.0
R:L foramen transversarium											
	R = L	M							4	0	0.0
		F							1	0	0.0
	R > L	M							—	2	50.0
		F							—	1	100.0
	R < L	M							—	2	50.0
		F							—	0	0.0
Superior articular surface											
	Single	M	9	9	10	10	100.0	100.0	19	19	100.0
		F	7	7	7	7	100.0	100.0	14	14	100.0
C-7											
Foramen transversarium											
	Single	M	7	6	5	5	85.7	100.0	12	11	91.7
		F	6	5	4	2	83.3	50.0	10	7	70.0
	Double	M	—	0	—	0	0.0	0.0	—	0	0.0
		F	—	1	—	1	16.7	25.0	—	2	20.0
	Spurred	M	—	1	—	0	14.3	0.0	—	1	8.3
		F	—	0	—	1	0.0	25.0	—	1	10.0
R:L foramen transversarium											
	R = L	M							3	0	0.0
		F							0	0	0.0
	R > L	M							—	3	100.0
		F							—	0	0.0
	R < L	M							—	0	0.0
		F							—	0	0.0

TABLE 21—Continued

AREA	VARIATION	SEX	RIGHT		LEFT		RIGHT	LEFT	TOTAL (RL)		
			n	N	*n*	N	%	%	*n*	N	%
Superior articular surface											
	Single	M	11	1	11	0	9.1	0.0	22	1	4.5
		F	8	0	7	0	0.0	0.0	15	0	0.0
	Double	M	—	10	—	11	90.9	100.0	—	21	95.5
		F	—	8	—	7	100.0	100.0	—	15	100.0

TABLE 22

SUMMARY OF VARIATIONS OF THE SPINOUS PROCESS OF THE CERVICAL VERTEBRAE

VERTEBRA	VARIATION	*n* (M/F)	NUMBER (M/F)		% (M/F)	TOTAL %
C-2	Bifid: parallel	13/5	M	5	38.5	38.9
			F	2	40.0	
	Bifid: divergent		M	8	61.5	61.1
			F	3	60.0	
C-3	Non-bifid (single)	5/3	M	2	40.0	37.5
			F	1	33.3	
	Bifid: parallel		M	0	0.0	0.0
			F	0	0.0	
	Bifid: divergent		M	3	60.0	62.5
			F	2	66.7	
C-4	Bifid: parallel	6/5	M	2	33.3	18.2
			F	0	0.0	
	Bifid: divergent		M	4	66.7	54.5
			F	2	40.0	
	Non-bifid (single)		M	0	0.0	27.3
			F	3	60.0	
C-5	Non-bifid (single)	3/5	M	1	33.3	37.5
			F	2	40.0	
	Bifid: parallel		M	1	33.3	37.5
			F	2	40.0	
	Bifid: divergent		M	1	33.3	25.0
			F	1	20.0	
C-6	Non-bifid (single)	6/6	M	3	50.0	58.3
			F	4	66.7	
	Bifid: parallel		M	1	16.7	16.7
			F	1	16.7	
	Bifid: divergent		M	2	33.3	25.0
			F	1	16.7	
C-7	Non-bifid (single)	12/6	M	10	83.3	88.9
			F	6	100.0	
	Bifid: parallel		M	2	16.7	11.1
			F	0	0.0	

Total	C-2 to C-6		C-7	
Bifid: parallel	14/57	24.6%	2/18	11.1%
Bifid: divergent	27/57	47.4	0/18	0.0
Non-bifid (single)	16/57	28.1	16/18	88.9

TABLE 23

SUMMARY OF LAMINAL SPURRING IN THE THORACIC AND LUMBAR VERTEBRAE

VERTEBRA	n (M/F)	N (M/F)	% (M/F)	TOTAL PERCENTAGES			
T-1	M 13	4	30.8				
	F 6	1	16.7				
T-2	M 14	6	42.9	M 48.7			
	F 5	2	40.0		42.6		
T-3	M 12	9	75.0	F 26.7			
	F 4	1	25.0				
T-4	M 10	7	70.0				
	F 5	5	100.0				
T-5	M 8	5	62.5	M 64.3			
	F 8	8	100.0		79.6		
T-6	M 10	6	60.0	F 100.0		M 65.9	
	F 8	8	100.0				
T-7	M 10	8	80.0				71.5
	F 8	8	100.0			F 82.1	
T-8	M 11	9	81.8	M 83.9			
	F 5	5	100.0		90.0		
T-9	M 10	9	90.0	F 100.0			
	F 6	6	100.0				
T-10	M 9	7	77.8				
	F 5	5	100.0				
T-11	M 10	8	80.0	M 71.4			
	F 3	2	66.7		77.5		
T-12	M 9	5	55.6	F 91.7			
	F 4	4	100.0				
L-1	M 8	2	25.0				
	F 6	5	83.3				
L-2	M 7	3	42.9				
	F 4	1	25.0				
L-3	M 8	2	25.0	M 26.3			
	F 5	3	60.0		35.0		
L-4	M 8	2	25.0	F 50.0			
	F 3	1	33.3				
L-5	M 7	1	14.3				
	F 4	1	25.0				

TABLE 24

MORPHOLOGICAL VARIATION FOUND IN THE LUMBAR AND SACRAL VERTEBRAE

TRAIT VARIATION	n (M/F)	NUMBER	PERCENTAGE	TOTAL (ADULTS) n	N	%
Lumbarization of S-1	M 7	0	0.0	14	0	0.0
	F 4	0	0.0			
Sacralization of L-5	M 7	0	0.0	14	0	0.0
	F 4	0	0.0			
Superior sacral hiatus	M 6			12		
	F 4					
to mid-S-1	M	0	0.0		0	0.0
	F	0	0.0			
S-1/S-2 junction	M	1	16.7		3	25.0
	F	1	25.0			
Mid-S-2	M	0	0.0		0	0.0
	F	0	0.0			
S-2/S-3	M	1	16.7		1	8.3
	F	0	0.0			
Inferior sacral hiatus	M 8			15		
	F 4					
Mid-S-5	M	0	0.0		0	0.0
	F	0	0.0			
S-5/S-4	M	2	25.0		2	13.3
	F	0	0.0			
Mid-S-4	M	1	12.5		2	13.3
	F	1	25.0			
S-4/S-3	M	3	37.5		4	26.7
	F	1	25.0			
Mid-S-3	M	1	0.0		1	6.7
	F	0	0.0			
S-3/S-2	M	0	0.0		2	13.3
	F	1	25.0			
?	M	1	12.5		1	6.7
	F	0	0.0			

TABLE 25

SUBADULT MORPHOLOGY

Spinous Process Form

Vertebra	(P) Parallel	(D) Divided	(S) Single	*n*	Incidences P	D	S
C-2	0	3	0	3	—	100.0	—
C-3	0	1	2	3	—	33.3	66.7
C-4	0	1	0	1	—	100.0	—
C-5	0	2	0	2	—	100.0	—
C-6	0	3	0	3	—	100.0	—
C-7	0	2	1	3	—	66.7	33.3

Foramen Transversarium Variation

Vertebra	Single	Double	R = L	R < L	R > L
C-1	5/5	0/5	5/5	0/5	0/5
	100.0	—	100.0	—	—
C-2	3/4	0/4	3/4	1/4	0/4
	75.0	—	75.0	25.0	—
C-3	4/4	0/4	4/4	0	0
	100.0	—	100.0	—	—
C-4	4/4	0/4	2/4	2/4	0/4
	100.0	—	50.0	50.0	—
C-5	3/3	0/3	3/3	0/3	0/3
	100.0	—	100.0	—	—
C-6	1/2	1/1	2/2	0/2	0/2
	50.0	100.0	100.0	—	—
C-7	2/2	0/2	1/2	0/2	1/2
	100.0	—	50.0	—	50.0

Laminal Spurring

Vertebra	Yes	No	% Yes	% No
T-2	0	3	—	100.0
T-3	0	3	—	100.0
T-3	0	0	—	100.0
T-4	1	2	33.3	66.7
T-5	2	1	66.7	33.3
T-6	2	1	66.7	33.3
T-7	2	1	66.7	33.3
T-8	2	1	66.7	33.3
T-9	2	1	66.7	33.3
T-10	2	1	66.7	33.3
T-11	2	1	66.7	33.3
T-12	2	1	66.7	33.3
L-1	1	2	33.3	66.7
L-2	1	2	33.3	66.7
L-3	1	3	25.0	75.0
L-4	1	3	25.0	75.0
L-5	1	3	25.0	75.0

TABLE 26

INFRACRANIAL MEASUREMENTS

BONE	MEASUREMENT	SIDE/INDIVIDUAL	MALE *n*	MALE RANGE	MALE MEAN	MALE S.D.	FEMALE *n*	FEMALE RANGE	FEMALE MEAN	FEMALE S.D.
Clavicle	Maximum length	R	7	13.0- 15.0	14.0	0.66	4	13.1- 15.2	14.1	0.77
		L	6	13.2- 14.9	13.9	0.55	4	12.8- 15.4	13.8	1.05
		I	9	13.2- 15.0	14.1	0.63	5	12.8- 15.4	13.9	9.54
Humerus	Maximum length	R	7	30.9- 33.4	32.4	0.75	6	29.7- 35.9	32.3	2.22
		L	9	30.8- 33.6	32.2	0.92	3	32.1- 36.0		
		I	10	30.8- 33.6	32.3	0.89	7	29.7- 36.0	28.1	10.37
	Minimum head diameter	R	9	3.9- 4.4	4.3	0.13	6	3.5- 4.5	4.0	0.36
		L	6	4.1- 4.4	4.3	0.11	6	3.7- 4.4	4.0	0.76
		I	10	3.9- 4.4	4.2	0.14	8	3.5- 4.5	4.0	3.3
	Maximum head diameter	R	10	4.2- 4.8	4.6	0.17	7	4.0- 4.9	4.3	0.35
		L	9	4.1- 4.9	4.5	0.27	6	3.6- 5.0	4.2	0.43
		I	11	4.2- 4.8	4.5	0.25	9	3.6- 5.0	4.2	4.3
Radius	Maximum length	R	6	24.0- 26.1	25.2	0.89	3	20.5- 26.0	22.9	2.0
		L	6	23.7- 25.4	24.5	0.66	2	23.0- 25.8	24.4	1.40
		I	7	23.7- 26.1	24.8	0.82	4	20.5- 25.8	22.9	1.91
	Maximum head diameter	R	9	2.2- 2.4	2.4	0.13	3	2.0- 2.8	2.3	0.38
		L	7	2.2- 2.6	2.4	0.12	3	2.1- 2.7	2.4	0.24
		I	10	2.2- 2.6	2.5	0.12	5	2.0- 2.7	2.2	0.27
Ulna	Maximum length	R	8	25.2- 28.6	26.9	1.0	5	23.0- 27.5	25.3	1.6
		L	5	25.0- 26.9	26.3	1.1	2	25.8- 28.0	26.9	1.1
		I	9	25.0- 28.6	26.7	1.1	5	23.0- 28.0	25.3	1.7
Femur	Maximum length	R	4	44.9- 47.4	46.1	0.9	3	42.3- 51.2	46.4	3.66
		L	6	44.3- 47.4	45.7	1.0	3	41.9- 50.9	46.3	3.68
		I	7	44.3- 47.4	45.7	0.93	4	41.9- 50.9	45.3	3.6
	Maximum head diameter	R	7	4.6- 5.0	4.8	0.15	6	4.1- 5.2	4.5	0.34
		L	8	4.6- 5.0	4.8	0.13	4	4.2- 5.2	4.6	0.36
		I	11	4.6- 5.0	4.8	0.14	6	4.2- 5.2	4.6	0.31

TABLE 26—Continued

BONE	MEASUREMENT	SIDE/INDIVIDUAL	MALE *n*	MALE RANGE	MALE MEAN	MALE S.D.	FEMALE *n*	FEMALE RANGE	FEMALE MEAN	FEMALE S.D.
	Subtrochanteric Ant.-post diameter	R	8	2.4- 3.0	2.7	0.19	9	2.3- 3.1	2.6	0.23
		L	8	2.5- 3.0	2.7	0.17	5	2.3- 2.8	2.5	0.19
		I	10	2.5- 3.0	2.7	0.18	9	2.3- 2.8	2.6	0.26
	Lat. diameter	R	8	2.7- 3.5	3.2	0.23	9	3.1- 3.5	3.1	0.41
		L	8	3.1- 3.7	3.3	0.18	5	3.0- 3.5	3.3	0.20
		I	9	3.1- 3.7	3.3	0.17	9	3.0- 3.5	3.3	0.19
	Platymeric index	R	8	72.7- 93.8	84.8	0.72	9	65.7- 90.3	79.7	7.07
		L	8	75.8- 88.8	81.9	0.39	5	65.7- 98.8	76.7	9.34
		I	10	75.8- 93.8	83.6	5.2	9	65.7- 98.8	81.8	10.7
	Mid-shaft transverse diameter	R	11	2.5- 3.0	2.7	0.17	7	2.4- 3.4	2.6	0.18
		L	8	2.5- 3.0	2.7	0.14	9	2.3- 2.9	2.6	0.17
		I	14	2.5- 3.0	2.7	0.17	10	2.3- 2.9	2.6	0.18
	Ant.-post diameter	R	11	2.7- 3.6	3.1	0.30	7	2.7- 3.4	3.0	0.23
		L	8	2.7- 3.6	3.1	0.29	9	2.5- 3.4	2.9	0.26
		I	14	2.7- 3.7	3.1	0.31	10	2.5- 3.4	3.6	0.24
	Pilastric index	R	11	100.0-136.0	116.9	0.12	7	107.4-125.0	113.7	0.57
		L	8	100.0-123.1	114.3	0.83	9	100.0-121.7	110.7	0.68
		I	14	100.0-123.3	114.8	10.2	9	100.0-121.7	110.7	6.82
TIBIA	Maximum length	R	6	36.3- 39.8	38.5	1.11	3	38.1- 41.2	39.6	1.27
		L	3	35.0- 39.5	37.6	1.90	3	35.7- 41.9	38.5	2.56
		I	7	36.3- 39.5	37.9	1.5	5	35.7- 41.9	38.6	2.0
	Transverse diameter	R	9	2.1- 2.9	2.6	0.29	8	2.2- 2.9	2.6	0.22
		L	10	2.1- 3.0	2.5	0.27	8	2.3- 2.7	2.5	0.13
		I	13	2.1- 3.1	2.5	0.29	10	2.3- 2.9	2.6	0.18
	Ant.-post diameter	R	9	3.4- 4.4	3.9	0.29	8	3.4- 4.0	3.7	0.22
		L	10	3.3- 4.4	3.8	0.36	8	3.3- 4.0	3.5	0.22
		I	13	3.3- 4.4	3.8	0.33	10	3.3- 4.0	3.6	0.24
	Platycnemic index	R	9	50.0- 75.6	66.1	6.7	8	56.4- 79.4	70.6	6.3
		L	10	48.8- 72.2	65.9	6.5	8	57.5- 76.5	70.6	5.7
		I	13	48.8- 75.6	66.6	6.3	10	57.5- 76.5	71.1	5.2

TABLE 26—Continued

BONE	MEASUREMENT	SIDE/INDIVIDUAL	MALE n	MALE RANGE	MALE MEAN	MALE S.D.	FEMALE n	FEMALE RANGE	FEMALE MEAN	FEMALE S.D.
Fibula	Maximum length	R	2	37.3- 38.1	37.7	4.0	1	—	34.7	—
		L	2	37.2- 38.6	37.2	4.5	1	—	39.9	—
		I	3	37.3- 38.6	38.0	0.53	1	—	39.9	—
Patella	Length	R	7	4.1- 4.8	4.4	0.25	6	3.6- 4.9	4.1	0.45
		L	5	4.2- 4.6	4.4	0.15	8	3.6- 4.9	4.1	0.40
	Width	R	7	4.1- 4.7	4.4	0.18	6	3.5- 4.9	4.2	0.42
		L	5	4.3- 4.9	4.6	0.19	8	3.8- 4.9	4.2	0.36
	Height	R	7	1.9- 2.3	2.1	0.13	6	1.9- 2.1	2.0	0.06
		L	5	2.1- 2.3	2.2	0.09	9	1.9- 2.1	2.0	0.29
	Module	R	7	3.4- 3.9	3.6	0.15	6	3.0- 4.0	3.5	0.30
		L	5	3.6- 3.9	3.7	0.11	9	3.1- 4.0	3.5	0.03
Lumbar Vertebrae	L1 Post. height		4	2.5- 2.9	2.7	0.18	6	2.6- 3.0	2.8	0.18
	Ant. height		3	2.4- 2.5	2.4	0.05	6	2.4- 2.9	2.6	0.19
	Lumbar index		3	104.2-116.0	109.5	4.91	6	103.4-116.7	108.6	4.5
	L2 Post. height		5	2.7- 3.0	2.8	0.26	4	2.7- 3.0	2.9	0.13
	Ant. height		4	2.4- 2.6	2.5	0.07	4	2.6- 3.0	2.8	0.14
	Index		4	108.0-120.0	113.0	4.4	4	100.0-107.1	102.7	3.0
	L3 Post. height		8	2.6- 3.0	2.7	0.09	4	2.3- 2.9	2.7	0.12
	Ant. height		7	2.4- 2.7	2.6	5.3	4	2.4- 3.0	2.7	0.21
	Index		7	100.0-115.4	106.6	5.3	4	86.7-108.3	101.1	7.9
	L4 Post. height		7	2.4- 2.8	2.6	0.15	4	2.5- 3.1	2.7	0.25
	Ant. height		5	2.4- 2.8	2.6	0.14	4	2.5- 2.8	2.7	0.13
	Index		5	96.0-107.7	100.1	5.4	4	89.3-110.7	100.0	7.6
	L5 Post. height		8	2.4- 2.8	2.6	0.12	5	2.4- 2.9	2.6	0.83
	Ant. height		8	2.2- 3.0	2.7	0.21	5	2.5- 2.9	2.7	0.21
	Index		8	83.3-108.0	95.3	6.6	5	88.9-100.0	94.2	4.2
L1-5	Vertebral index		1		108.2		3		101.1	

TABLE 27

MORPHOLOGICAL VARIATION AS FOUND IN THE INFRACRANIAL SKELETON

BONE	TRAIT	VARIATION	MALE N R	MALE N L	MALE N T	MALE % R	MALE % L	MALE % T	FEMALE N R	FEMALE N L	FEMALE N T	FEMALE % R	FEMALE % L	FEMALE % T	GRAND TOTAL RL	GRAND TOTAL %
Scapula	Suprascapular	*n*	6	6	12	—	—	—	2	2	4	—	—	—	16	—
		Nothing	0	2	2	0.0	33.3	16.7	0	0	0	0.0	0.0	0.0	2	12.5
		Notch	6	4	10	100.0	66.7	83.3	2	1	3	100.0	50.0	75.0	13	81.3
		Foramen	0	0	0	0.0	0.0	0.0	0	1	1	0.0	50.0	25.0	1	6.2
	Acromion	*n*	6	6	12	—	—	—	3	2	5	—	—	—	17	—
		Rectangle	4	6	10	66.7	100.0	83.3	2	1	3	66.7	50.0	60.0	13	76.5
		Triangle	1	0	1	16.7	0.0	8.3	1	1	2	33.3	50.0	40.0	3	17.6
		Sickle	1	0	1	16.7	0.0	8.3	0	0	0	0.0	0.0	0.0	1	5.9
	Inf. angle	*n*	2	2	4	—	—	—	1	1	2	—	—	—	6	—
		V-shaped	0	0	0	0.0	0.0	0.0	1	1	2	100.0	100.0	100.0	2	33.3
		U-shaped	2	2	4	100.0	100.0	100.0	0	0	0	0.0	0.0	0.0	4	66.7
Humerus	Supratrochlear spur	*n*	14	14	28	—	—	—	8	2	10	—	—	—	45	—
		Presence	0	0	0	0.0	0.0	0.0	0	0	0	0.0	0.0	0.0	0	0.0
	Septal aperture	*n*	11	12	23	—	—	—	8	2	10	—	—	—	39	—
		Presence	0	0	0	0.0	0.0	0.0	1	0	1	12.5	0.0	10.0	6	15.4
Innominate	Acetabular notch	*n*	8	10	18	—	—	—	3	2	5	—	—	—	23	—
		Presence	2	3	5	25.0	30.0	27.8	2	1	3	66.7	50.0	60.0	8	34.8
Femur	Fossa of Allen	*n*	6	7	13	—	—	—	2	2	4	—	—	—	24	—
		Presence	0	0	0	0.0	0.0	0.0	0	0	0	0.0	0.0	0.0	2	8.3
	Third trochanter	*n*	7	8	15	—	—	—	3	4	7	—	—	—	31	—
		None	0	0	0	0.0	0.0	0.0	0	0	0	0.0	0.0	0.0	1	3.2
		Presence	0	0	0	0.0	0.0	0.0	0	0	0	0.0	0.0	0.0	0	0.0
		Ridge	7	8	15	100.0	100.0	100.0	3	4	7	100.0	100.0	100.0	30	96.8
Tibia	Tibia squatting facet	*n*	2	1	3	—	—	—	1	2	3	—	—	—	12	—
		Medial	0	0	0	0.0	0.0	0.0	0	0	0	0.0	0.0	0.0	3	25.0
		Lateral	1	1	2	50.0	100.0	66.7	0	0	0	0.0	0.0	0.0	3	25.0
		Neck	0	0	0	0.0	0.0	0.0	1	2	3	100.0	100.0	100.0	3	25.0

TABLE 27—Continued

BONE	TRAIT	VARIATION	MALE N R	MALE N L	MALE N T	MALE % R	MALE % L	MALE % T	FEMALE N R	FEMALE N L	FEMALE N T	FEMALE % R	FEMALE % L	FEMALE % T	GRAND TOTAL RL	GRAND TOTAL %
		n	12	12	24	—	—	—	5	6	11	—	—	—	35	—
	Talar squatting facet	Medial	4	4	8	33.3	33.3	33.3	1	3	4	20.0	50.0	36.4	12	34.3
		Neck	2	1	3	16.7	8.3	12.5	1	2	3	20.0	33.3	27.3	6	17.1
		Med. + Lat.	1	1	2	8.3	8.3	8.3	0	0	0	0.0	0.0	0.0	2	5.7
		Med. + Neck	0	0	0	0.0	0.0	0.0	1	0	1	10.0	0.0	9.1	1	2.9
Talus		Lat. + Neck	0	1	1	0.0	8.3	4.2	0	0	0	0.0	0.0	0.0	1	2.9
		M + L + N	1	1	2	8.3	8.3	8.3	0	0	0	0.0	0.0	0.0	2	5.7
		n	3	2	5	—	—	—	1	3	4	—	—	—	9	—
	Talar extension	Medial	0	1	1	0.0	50.0	20.0	0	1	1	0.0	33.3	25.0	4	44.4
		Lateral	0	0	0	0.0	0.0	0.0	0	1	1	0.0	33.3	25.0	1	11.1
		Med. + Lat.	1	0	1	33.3	0.0	20.0	0	1	1	0.0	33.3	25.0	2	22.2
		n	—	—	4	—	—	—	—	—	2	—	—	—	6	—
Sternum	Sternal aperture	Presence	—	—	0	—	—	0.0	—	—	0	—	—	0.0	0	0.0
		n	9	8	17	—	—	—	4	4	8	—	—	—	25	—
Patella	Vastus notch	Presence	0	1	1	0.0	12.5	5.9	1	1	2	25.0	25.0	25.0	3	12.0
		n	6	7	13	—	—	—	3	7	10	—	—	—	23	—
Navicular	Posterior navicular surface	Inf. extens.	3	6	9	50.0	85.7	69.2	2	4	6	66.7	57.1	60.0	15	65.2
		Tub. pitted	3	1	4	50.0	14.3	30.8	1	3	4	33.3	42.9	40.0	8	34.8
		n	13	13	26	—	—	—	5	5	10	—	—	—	36	—
Calcaneus	Calcaneal facet	Single	1	1	2	7.7	7.7	7.7	0	0	0	0.0	0.0	0.0	2	5.6
		Double	4	2	6	30.8	15.4	23.1	1	1	2	20.0	20.0	20.0	8	22.2
		Constricted	8	10	18	61.5	76.9	69.2	4	4	8	80.0	80.0	80.0	26	72.2

TABLE 28

SUBADULT INFRACRANIAL MORPHOLOGY

TRAIT	VARIATION	n	N	%	TOTAL (ADULT-SUBADULT & RL) n	N	%
Sternal aperture							
	Presence	3	0	0.0	9	0	0.0
Suprascapular notch							
	Right	1	1	100.0			
	Left	1	1	100.0			
	Total	2	2	100.0	18	15	83.3
Acromion (rectangular)							
	Right	2	2	100.0			
	Left	1	1	100.0			
	Total	3	3	100.0	20	16	80.0
Inferior angle (V)							
	Right	1	1	100.0			
	Left	1	1	100.0			
	Total	2	2	100.0			
Supratrochlear spur							
	Right	4	0	0.0			
	Left	3	0	0.0			
	Total	7	0	0.0	52	0	0.0
Septal aperture							
	Right	2	0	0.0			
	Left	3	0	0.0			
	Total	5	0	0.0	44	6	13.6
Acetabular notch							
	Right	2	0	0.0			
	Left	1	1	100.0			
	Total	3	1	33.3	26	9	34.6
Vastus notch							
	Right	0	—	—			
	Left	1	0	0.0	26	4	15.4
T-3 (ridge)							
	Right	3	3	100.0			
	Left	2	2	100.0			
	Total	5	5	100.0	36	35	97.2
Talar facet							
	Right	0	—	—			
	Left	1	0	0.0			
Calcaneus (constricted)							
	Right	0	—	—			
	Left	1	1	100.0			
	Total	1	1	100.0	37	27	73.0

TABLE 29

STATURE ESTIMATIONS FOR THE ADULT SERIES

CATALOGUE NUMBER	BASED ON MONGOLOID FORMULAE cm	BASED ON CAUCASOID FORMULAE cm
Male		
To-At-1- 7	165.1 ± 3.27	166.6 ± 4.00
To-At-1-10	168.7 ± 3.24	168.6 ± 3.74
To-At-1-10B	170.8 ± 3.80	171.6 ± 3.94
To-At-1-12	170.1 ± 4.60	173.8 ± 4.66
To-At-1-16	172.1 ± 3.18	172.4 ± 3.62
To-At-1-21A	175.9 ± 3.24	176.1 ± 3.74
To-At-1-29	171.5 ± 3.18	171.8 ± 3.62
To-At-1-31	174.9 ± 3.27	176.6 ± 4.00
To-At-1-34	171.9 ± 3.80	172.7 ± 3.94
To-At-2- 6	175.9 ± 3.27	177.5 ± 4.00
To-At-2-13	169.0 ± 4.25	170.6 ± 4.57
To-At-2-13A	168.4 ± 4.16	169.9 ± 4.41
To-At-2-22	169.4 ± 4.16	171.0 ± 4.31
To-At-2-31	170.4 ± 3.80	171.1 ± 3.94
To-At-2-37	173.0 ± 3.27	174.6 ± 4.00
To-At-2-42	165.7 ± 4.25	167.1 ± 4.57
Female		
To-At-1-11	169.2 ± 4.25	170.9 ± 4.57
To-At-1-19	173.0 ± 3.24	173.1 ± 3.74
To-At-2- 1C	161.0 ± 4.16	161.9 ± 4.31
To-At-2- 4	181.0 ± 3.18	182.0 ± 3.62
To-At- 2-16	162.8 ± 4.25	163.9 ± 4.57
To-At-2-20	172.5 ± 3.27	174.1 ± 4.00
To-At-2-27	175.6 ± 3.27	177.3 ± 4.00
To-At-2-27A	162.7 ± 3.80	166.6 ± 3.94
To-At-2-30	163.4 ± 4.60	166.6 ± 4.66
To-At-2-40A	162.3 ± 4.16	163.3 ± 4.31
Range		
M	165.1 ± 3.27 - 175.9 ± 3.27	166.6 ± 4.00 - 177.5 ± 4.00
F	161.0 ± 4.16 - 181.0 ± 3.18	161.9 ± 4.31 - 182.0 ± 3.62

TABLE 30

LIMB PROPORTION INDICES

INDIVIDUAL	BRACHIAL	TIBIO-FEMORAL	INTERMEMBRAL
To-At-1- 6	78.7	82.9	67.7
To-At-1- 7	76.7	—	—
To-At-1- 9	76.5	—	—
To-At-1-19	—	82.4	—
To-At-1-29	79.4 (R)	87.1 (R)	70.7 (R)
To-At-1-34	79.5 (R)	—	—
To-At-2- 4	71.7	82.3	66.6
To-At-2-13C	74.9	—	—
To-At-2-22	73.9	—	—

TABLE 31

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC INVOLVEMENT AT THE SHOULDER, ELBOW, AND HIP ACCORDING TO SEX

ARTICULAR SURFACE	*n*			NUMBER			PERCENTAGE		
	M	F	T	M	F	T	M	F	TOTAL
R sterno-clavicle	8	4	12	3	1	4	37.5	25.0	33.3
L sterno-clavicle	6	3	9	2	0	2	33.3	0.0	22.2
Total	14	7	21	5	1	6	35.7	14.3	28.6
R acromion-clavicle	9	3	12	2	1	3	22.2	33.3	25.0
L acromion-clavicle	3	2	5	1	1	2	33.3	50.0	40.0
Total	12	5	17	3	2	5	25.0	40.0	29.4
R glenoid	10	4	14	5	2	7	50.0	50.0	50.0
L glenoid	10	2	12	4	1	5	40.0	50.0	41.7
Total	20	6	26	9	3	12	45.0	50.0	46.2
R humerus, head	9	6	15	1	3	4	11.1	50.0	26.7
L humerus, head	8	2	10	2	0	2	25.0	0.0	20.0
Total	17	8	25	3	3	6	17.6	37.5	24.0
R capitulum	7	7	14	2	4	6	28.6	57.1	42.9
L capitulum	11	2	13	3	1	4	27.3	50.0	30.8
Total	18	9	27	5	5	10	27.8	55.6	37.0
R trochlea	7	8	15	3	4	7	42.9	50.0	46.7
L trochlea	10	2	12	3	2	5	30.0	100.0	41.7
Total	17	10	27	6	6	12	35.3	60.0	44.4
R proximal ulna	10	5	15	7	5	12	70.0	100.0	80.0
L proximal ulna	11	5	16	10	5	15	90.9	100.0	93.8
Total	21	10	31	17	10	27	81.0	100.0	87.1
R sacro-iliac	7	2	9	5	2	7	71.4	100.0	77.8
L sacro-iliac	6	1	7	3	1	4	50.0	100.0	57.1
Total	13	3	16	8	3	11	61.5	100.0	68.8
R acetabulum	10	4	14	2	1	3	20.0	25.0	21.4
L acetabulum	7	1	8	3	0	3	42.9	0.0	37.5
Total	17	5	22	5	1	6	29.4	20.0	27.3
R femur, head	4	4	8	0	1	1	0.0	25.0	12.5
L femur, head	4	1	5	0	1	1	0.0	100.0	20.0
Total	8	5	13	0	2	2	0.0	40.0	15.4

TABLE 32

SUMMARY OF ARTHRITIC INVOLVEMENT AT THE KNEE REGION

ARTICULAR SURFACE	*n*			NUMBER			%		
	M	F	T	M	F	T	M	F	T
R distal femur	1	1	2	1	1	2	100.0	100.0	100.0
L distal femur	2	2	4	1	1	2	50.0	50.0	50.0
Total (R & L)	3	3	6	2	2	4	66.7	66.7	66.7
R proximal tibia	4	2	6	1	1	2	25.0	50.0	33.3
L proximal tibia	5	4	9	2	1	3	40.0	25.0	33.3
Total	9	6	15	3	2	5	33.3	33.3	33.3
R patella	9	4	13	6	2	8	66.7	50.0	61.5
L patella	10	5	15	5	1	6	50.0	20.0	40.0
Total	19	9	28	11	3	14	57.9	33.3	50.0
R proximal fibula	4	1	5	3	1	4	75.0	100.0	80.0
L proximal fibula	1	2	3	0	2	2	0.0	100.0	66.7
Total	5	3	8	3	3	6	60.0	100.0	75.0

TABLE 33

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC INVOLVEMENT IN THE WRIST REGION

ARTICULAR SURFACE	*n*			NUMBER			%		
	M	F	T	M	F	T	M	F	T
R distal radius	9	4	13	6	4	10	66.7	100.0	76.9
R distal ulna	7	4	11	1	2	3	14.3	50.0	27.3
L distal radius	12	4	16	8	3	11	66.7	75.0	68.8
L distal ulna	5	2	7	2	1	3	40.0	50.0	42.9
R pisiform	3	4	7	2	2	4	66.7	50.0	57.1
L pisiform	2	1	3	1	0	1	50.0	0.0	33.3
R hamate	7	6	13	5	3	8	71.4	50.0	61.5
L hamate	8	2	10	6	0	6	75.0	0.0	60.0
R capitate	7	6	13	5	3	8	71.4	50.0	61.5
L capitate	7	4	11	5	0	5	71.4	0.0	45.5
R trapezoid	8	2	10	6	2	8	75.0	100.0	80.0
L trapezoid	3	1	4	1	0	1	33.3	0.0	25.0
R trapezium	4	2	6	4	2	6	100.0	100.0	100.0
L trapezium	7	1	8	6	0	6	85.7	0.0	75.0
R scaphoid	6	6	12	4	3	7	66.7	50.0	58.3
L scaphoid	6	3	9	5	0	5	83.3	0.0	55.6
R lunate	6	4	10	6	3	9	100.0	75.0	90.0
L lunate	3	0	3	2	0	2	66.7	0.0	66.7
R triquetrum	3	3	6	3	2	5	100.0	66.7	83.3
L triquetrum	5	1	6	4	0	4	80.0	0.0	66.7

TABLE 34

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC CHANGES ON THE PROXIMAL AND DISTAL EXTREMITIES OF THE METACARPALS ACCORDING TO MOUND ASSOCIATION

ARTICULAR SURFACE	*n*			NUMBER			%		
	I	II	TOTAL	I	II	TOTAL	I	II	TOTAL
R proximal MC-1	11	11	22	4	5	9	36.4	45.5	40.9
L proximal MC-1	5	10	15	2	6	8	40.0	60.0	53.3
Total	16	21	37	6	11	17	37.5	52.4	45.9
R distal MC-1	11	12	23	1	3	4	9.1	25.0	17.4
L distal MC-1	5	11	16	1	3	4	20.0	27.3	25.0
Total	16	23	39	2	6	8	12.5	26.1	20.5
R proximal MC-2	9	10	19	4	5	9	44.4	50.0	47.4
L proximal MC-2	7	9	16	3	6	9	42.9	66.7	56.3
Total	16	19	35	7	11	18	43.8	57.9	51.4
R distal MC-2	10	9	19	1	1	2	10.0	11.1	10.5
L distal MC-2	7	8	15	1	0	1	14.3	0.0	6.7
Total	17	17	34	2	1	3	11.8	5.9	8.8
R proximal MC-3	9	11	20	2	5	7	22.2	45.5	35.0
L proximal MC-3	5	9	14	3	5	8	60.0	55.5	57.1
Total	14	20	34	5	10	15	35.7	50.0	44.1
R distal MC-3	8	11	19	1	1	2	12.5	9.1	10.5
L distal MC-3	5	6	11	1	0	1	20.0	0.0	9.1
Total	13	17	30	2	1	3	15.4	5.9	10.0
R proximal MC-4	10	10	20	4	6	10	40.0	60.0	50.0
L proximal MC-4	5	10	15	3	6	9	60.0	60.0	60.0
Total	15	20	35	7	12	19	46.7	60.0	54.3
R distal MC-4	10	10	20	1	0	1	10.0	0.0	5.0
L distal MC-4	5	7	12	1	0	1	20.0	0.0	8.3
Total	15	17	32	2	0	2	13.3	0.0	6.3
R proximal MC-5	10	9	19	5	6	11	50.0	66.7	57.9
L proximal MC-5	4	9	13	3	5	8	75.0	55.6	61.5
Total	14	18	32	8	11	19	57.1	61.1	59.4
R distal MC-5	10	9	19	1	1	2	10.0	11.1	10.5
L distal MC-5	4	5	9	1	0	1	25.0	0.0	11.1
Total	14	14	28	2	1	3	14.3	7.1	10.7

TABLE 35

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC INVOLVEMENT OCCURRING AT THE ANKLE

ARTICULAR SURFACE	n			NUMBER			%		
	M	F	T	M	F	T	M	F	TOTAL
R distal tibia	9	3	12	5	1	6	55.6	33.3	50.0
L distal tibia	5	3	8	3	0	3	60.0	0.0	37.5
Total	14	6	20	8	1	9	57.1	16.7	45.0
R distal fibula	7	5	12	3	3	6	42.9	60.0	50.0
L distal fibula	7	3	10	2	2	4	28.6	66.7	40.0
Total	14	8	22	5	5	10	35.7	62.5	45.5
R T-F, talus	11	5	16	2	2	4	18.2	40.0	25.0
L T-F, talus	12	6	18	3	3	6	25.0	50.0	33.3
Total	23	11	34	5	5	10	21.7	45.5	29.4
R talus, head	11	5	16	2	4	6	18.2	80.0	36.5
L talus, head	11	6	17	6	4	10	54.5	66.7	58.8
Total	22	11	33	8	8	16	36.4	72.7	48.5
R talus, inf.	12	4	16	8	4	12	67.3	100.0	75.0
L talus, inf.	12	6	18	8	4	12	66.7	66.7	66.7
Total	24	10	34	16	8	24	66.7	80.0	70.6
R calcaneus	12	7	19	9	5	14	75.0	71.4	73.7
L calcaneus	11	4	15	8	3	11	72.7	75.0	73.3
Total	23	11	34	17	8	25	73.9	72.7	73.5
R navicular	13	6	19	7	4	11	53.8	66.7	57.9
L navicular	12	6	18	9	3	12	75.0	50.0	66.7
Total	25	12	37	16	7	23	64.0	58.3	62.2
R cuboid	13	3	16	8	3	11	61.5	100.0	68.8
L cuboid	11	4	15	8	3	11	72.7	75.0	73.3
Total	24	7	31	16	6	22	66.7	85.7	71.0
R cuneiform-1	8	3	11	4	2	6	50.0	66.7	54.5
L cuneiform-1	11	5	16	6	2	8	54.5	40.0	50.0
Total	19	8	27	10	4	14	52.6	50.0	51.9
R cuneiform-2	11	4	15	4	2	6	36.4	50.0	40.0
L cuneiform-2	13	7	20	6	2	8	46.2	28.6	40.0
Total	24	11	35	10	4	14	41.7	36.4	40.0
R cuneiform-3	9	5	14	3	2	5	33.3	40.0	35.7
L cuneiform-3	11	5	16	7	2	9	63.6	40.0	56.3
Total	20	10	30	10	4	14	50.0	40.0	46.7

TABLE 36

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC CHANGES AT THE PROXIMAL AND DISTAL EXTREMITIES OF THE METATARSALS ACCORDING TO SEX

ARTICULAR SURFACE	*n* M	*n* F	*n* T	NUMBER M	NUMBER F	NUMBER T	% M	% F	% TOTAL
R proximal MT-1	9	6	15	5	2	7	55.6	33.3	46.7
L proximal MT-1	13	5	18	7	3	10	53.8	60.0	55.6
Total	22	11	33	12	5	17	54.5	45.5	51.5
R distal MT-1	9	6	15	0	2	2	0.0	33.3	13.3
L distal MT-1	13	6	19	2	1	3	15.4	16.7	15.8
Total	22	12	34	2	3	5	9.1	25.0	14.7
R proximal MT-2	10	4	14	3	2	5	30.0	50.0	35.7
L proximal MT-2	10	7	17	6	2	8	60.0	28.6	47.1
Total	20	11	31	9	4	13	45.0	36.4	41.9
R distal MT-2	8	3	11	0	0	0	0.0	0.0	0.0
L distal MT-2	11	5	16	1	1	2	9.1	20.0	12.5
Total	19	8	27	1	1	2	5.3	12.5	7.4
R proximal MT-3	8	5	13	2	2	4	25.0	40.0	30.8
L proximal MT-3	10	6	16	4	2	6	40.0	33.3	37.5
Total	18	11	29	6	4	10	33.3	36.4	34.5
R distal MT-3	6	5	11	0	0	0	0.0	0.0	0.0
L distal MT-3	6	4	10	0	0	0	0.0	0.0	0.0
Total	12	9	21	0	0	0	0.0	0.0	0.0
R proximal MT-4	9	7	16	4	2	6	44.4	28.6	37.5
L proximal MT-4	12	7	19	5	2	7	41.7	28.6	36.8
Total	21	14	35	9	4	13	42.9	28.6	37.1
R distal MT-4	8	7	15	0	0	0	0.0	0.0	0.0
L distal MT-4	12	6	18	0	0	0	0.0	0.0	0.0
Total	20	13	33	0	0	0	0.0	0.0	0.0
R proximal MT-5	10	5	15	4	1	5	40.0	20.0	33.3
L proximal MT-5	12	6	18	5	2	7	41.7	33.3	38.9
Total	22	11	33	9	3	12	40.9	27.3	36.4
R distal MT-5	10	5	15	1	0	1	10.0	0.0	6.7
L distal MT-5	12	4	16	2	0	2	16.7	0.0	12.5
Total	22	9	31	3	0	3	13.6	0.0	9.7

TABLE 37

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC CHANGES AT THE PROXIMAL AND DISTAL EXTREMITIES OF THE HAND AND FOOT PHALANGES ACCORDING TO SEX

ARTICULAR SURFACE	*n*			NUMBER			PERCENTAGE		
	M.	F.	T.	M.	F.	T.	M.	F.	T.
R Prox. MC-1, Prox.		9	—		3	—		33.3	—
	9			2			22.2		
L Prox. MC-1, Prox.		7	—		2	—		28.6	—
Total	9	16	25	2	5	7	11.1	31.3	28.0
R Prox. MC-1, Dist.		9	—		1	1		11.1	—
	9			0			0.0		
L Prox. MC-1, Dist.		7	—		0	0		0.0	—
Total	9	16	25	0	1	1	0.0	6.3	4.0
R Dist. MC-1, Prox.		5	—		3	—		60.0	—
	4			1			25.0		
L Dist. MC-1, Prox.		5	—		4	—		80.0	—
Total	4	10	14	1	7	8	25.0	70.0	57.1
R Dist. MC-1, Dist.		5	—		0	—		0.0	—
	4			4			100.0		
L Dist. MC-1, Dist.		5	—		0	—		0.0	—
Total	4	10	14	4	0	4	100.0	0.0	28.5
All hand phalanges									
Prox. Phal., Prox.	57	58	115	7	6	13	12.3	10.3	11.3
Prox. Phal., Dist.	58	62	120	0	4	4	0.0	6.5	3.3
Medial Phal., Prox.	46	40	86	6	4	10	13.0	10.0	11.6
Medial Phal., Dist.	46	39	85	0	0	0	0.0	0.0	0.0
Dist. Phal., Prox.	15	24	39	3	0	3	20.0	0.0	7.7
Dist. Phal., Dist.	16	24	40	0	0	0	0.0	0.0	0.0
R Prox. MT-1, Prox.	5	3	8	3	1	4	60.0	33.3	50.0
L Prox. MT-1, Prox.	1	10	11	1	3	4	100.0	30.0	36.4
Total	6	13	19	4	4	8	66.7	30.8	42.1
R Prox. MT-1, Dist.	4	4	8	0	0	0	0.0	0.0	0.0
L Prox. MT-1, Dist.	0	10	10	0	2	2	0.0	20.0	20.0
Total	4	14	18	0	2	2	0.0	14.3	11.1
R Dist. MT-1, Prox.	4	1	5	2	1	3	50.0	100.0	60.0
L Dist. MT-1, Prox.	1	5	6	1	4	5	100.0	80.0	83.3
Total	5	6	11	3	5	8	60.0	83.3	72.7
R Dist. MT-1, Dist.	3	1	4	0	1	1	0.0	100.0	25.0
L Dist. MT-1, Dist.	1	5	6	0	2	2	0.0	40.0	33.3
Total	4	6	10	0	3	3	0.0	50.0	30.0
All foot phalanges									
Prox. Phal., Prox.	26	45	71	4	13	17	15.4	28.9	23.9
Prox. Phal., Dist.	27	44	71	0	0	0	0.0	0.0	0.0
Medial Phal., Prox.	15	20	35	5	0	5	33.3	0.0	14.3
Medial Phal., Dist.	15	20	35	0	0	0	0.0	0.0	0.0
Dist. Phal., Prox.	7	9	16	0	0	0	0.0	0.0	0.0
Dist. Phal., Dist.	7	9	16	0	0	0	0.0	0.0	0.0

TABLE 38

FREQUENCY OF OCCURRENCE OF ARTHRITIC INVOLVEMENT ON VERTEBRAL BODIES

SURFACE	*n*			NUMBER			PERCENTAGE		
	M.	F.	T.	M.	F.	T.	M.	F.	T.
C-2, Inferior	15	8	23	0	1	1	0.0	12.5	4.3
C-3, Superior	14	9	23	3	1	4	21.4	11.1	17.4
C-3, Inferior	14	9	23	5	1	6	35.7	11.1	26.1
C-4, Superior	15	8	23	4	2	6	26.7	25.0	26.1
C-4, Inferior	15	8	23	2	2	4	13.3	25.0	17.4
C-5, Superior	13	9	22	4	1	5	30.8	11.1	22.7
C-5, Inferior	13	9	22	4	1	5	30.8	11.1	22.7
C-6, Superior	11	8	19	3	1	4	27.3	12.5	21.1
C-6, Inferior	13	8	21	6	1	7	53.8	12.5	33.3
C-7, Superior	14	6	20	5	1	6	35.7	16.7	30.0
C-7, Inferior	14	7	21	2	1	3	14.3	14.3	14.3
All Cerv., Superior	84	49	133	19	6	25	22.6	12.2	18.8
All Cerv., Inferior	67	40	107	19	7	26	28.4	17.5	24.3
T-1, Superior	15	4	19	4	0	4	26.7	0.0	21.1
T-1, Inferior	14	4	18	1	0	1	7.1	0.0	5.6
T-2, Superior	13	5	18	3	0	3	23.1	0.0	16.7
T-2, Inferior	13	5	18	2	0	2	15.4	0.0	11.1
T-3, Superior	11	5	16	6	0	6	54.5	0.0	37.5
T-3, Inferior	11	5	16	2	0	2	18.2	0.0	12.5
T-4, Superior	12	6	18	3	1	4	25.0	16.7	22.2
T-4, Inferior	12	6	18	1	1	2	8.3	16.7	11.1
T-5, Superior	10	7	17	2	1	3	20.0	14.3	17.6
T-5, Inferior	10	7	17	2	0	2	20.0	0.0	11.8
T-6, Superior	12	5	17	2	1	3	16.7	20.0	17.6
T-6, Inferior	13	5	18	3	0	3	23.1	0.0	16.7
T-7, Superior	13	5	18	3	1	4	23.1	20.0	22.2
T-7, Inferior	13	5	18	3	1	4	23.1	20.0	22.2
T-8, Superior	10	6	16	4	2	6	40.0	33.3	37.5
T-8, Inferior	11	6	17	3	2	5	27.3	33.3	29.4
T-9, Superior	12	6	18	3	1	4	25.0	16.7	22.2
T-9, Inferior	12	6	18	2	1	3	16.7	16.7	16.7
T-10, Superior	10	6	16	3	0	3	30.0	0.0	18.8
T-10, Inferior	10	6	16	2	0	2	20.0	0.0	12.5
T-11, Superior	10	6	16	1	0	1	10.0	0.0	6.3
T-11, Inferior	10	6	16	1	0	1	10.0	0.0	6.3
T-12, Superior	10	6	16	1	0	1	10.0	0.0	6.3
T-12, Inferior	10	5	15	1	0	1	10.0	0.0	6.7
All Thor., Superior	138	67	205	35	7	42	25.4	10.4	20.5
All Thor., Inferior	138	66	204	23	5	28	16.7	7.6	13.7
L-1, Superior	10	8	18	1	1	2	10.0	12.5	11.1
L-1, Inferior	10	7	17	1	2	3	10.0	28.6	17.6
L-2, Superior	8	4	12	2	2	4	25.0	50.0	33.3
L-2, Inferior	8	4	12	2	1	3	25.0	25.0	25.0
L-3, Superior	6	3	9	4	1	5	66.7	33.3	55.6
L-3, Inferior	7	3	10	4	1	5	57.1	33.3	50.0
L-4, Superior	6	5	11	4	1	5	66.7	20.0	45.5
L-4, Inferior	5	5	10	3	1	4	60.0	20.0	40.0
L-5, Superior	6	6	12	3	2	5	50.0	33.3	41.7
L-5, Inferior	6	6	12	3	3	6	50.0	50.0	50.0
All Lumbar, Superior	36	26	62	14	7	21	38.9	26.9	33.9
All Lumbar, Inferior	36	25	61	13	8	21	36.1	32.0	34.4

TABLE 39

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC INVOLVEMENT ON THE ARTICULAR SURFACES OF THE CERVICAL VERTEBRAE

ARTICULAR SURFACE	*n*			NUMBER			PERCENTAGE		
	M.	F.	T.	M.	F.	T.	M.	F.	T.
C-1, R Superior	11	8	19	6	3	9	54.5	37.5	47.4
C-1, R Inferior	11	8	19	6	3	9	54.5	37.5	47.4
C-1, L Superior	13	7	20	6	3	9	46.2	42.9	45.0
C-1, L Inferior	13	7	20	6	3	9	46.2	42.9	45.0
C-2, R Superior	16	8	24	3	3	6	18.8	37.5	25.0
C-2, R Inferior	16	5	21	6	3	9	37.5	60.0	42.9
C-2, L Superior	15	8	23	3	3	6	20.0	37.5	26.1
C-2, L Inferior	15	5	20	2	1	3	13.3	20.0	15.0
C-3, R Superior	14	8	22	2	0	2	14.3	0.0	9.1
C-3, R Inferior	14	8	22	3	0	3	21.4	0.0	13.6
C-3, L Superior	13	6	19	2	0	2	15.4	0.0	10.5
C-3, L Inferior	13	6	19	2	0	2	15.4	0.0	10.5
C-4, R Superior	14	9	23	1	0	1	7.1	0.0	4.3
C-4, R Inferior	14	9	23	3	0	3	21.4	0.0	13.0
C-4, L Superior	13	9	22	3	0	3	23.1	0.0	13.6
C-4, L Inferior	13	9	22	3	0	3	23.1	0.0	13.6
C-5, R Superior	12	9	21	4	1	5	33.3	11.1	23.8
C-5, R Inferior	11	8	19	2	0	2	18.2	0.0	10.5
C-5, L Superior	11	9	20	2	0	2	18.2	0.0	10.0
C-5, L Inferior	11	9	20	2	0	2	18.2	0.0	10.0
C-6, R Superior	12	8	20	1	0	1	8.3	0.0	5.0
C-6, R Inferior	11	8	19	0	0	0	0.0	0.0	0.0
C-6, L Superior	11	8	19	1	0	1	9.1	0.0	5.3
C-6, L Inferior	10	8	18	0	0	0	0.0	0.0	0.0
C-7, R Superior	13	8	21	1	0	1	7.7	0.0	4.8
C-7, R Inferior	14	8	22	1	0	1	7.1	0.0	4.5
C-7, L Superior	13	6	19	0	0	0	0.0	0.0	0.0
C-7, L Inferior	14	6	20	1	0	1	7.1	0.0	5.0
All cervical									
R Superior	92	58	150	18	7	25	19.6	12.1	16.7
R Inferior	94	54	148	18	4	22	19.1	7.4	14.9
L Superior	89	53	142	17	6	23	19.1	11.3	16.2
L Inferior	78	41	119	14	4	18	17.9	9.8	15.1

TABLE 40

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC INVOLVEMENT ON THE ARTICULAR SURFACES OF THE THORACIC VERTEBRAE

ARTICULAR SURFACE	*n*			NUMBER			PERCENTAGE		
	M.	F.	T.	M.	F.	T.	M.	F.	T.
T-1, R Superior	14	6	20	0	1	1	0.0	16.7	5.0
T-1, R Inferior	14	6	20	0	0	0	0.0	0.0	0.0
T-1, L Superior	14	6	20	0	0	0	0.0	0.0	0.0
T-1, L Inferior	14	6	20	0	0	0	0.0	0.0	0.0
T-2, R Superior	14	6	20	1	0	1	7.1	0.0	5.0
T-2, R Inferior	15	6	21	1	0	1	6.7	0.0	4.8
T-2, L Superior	15	5	20	1	0	1	6.7	0.0	5.0
T-2, L Inferior	15	5	20	1	0	1	6.7	0.0	5.0
T-3, R Superior	14	5	19	1	1	2	7.1	20.0	10.5
T-3, R Inferior	14	5	19	1	1	2	7.1	20.0	10.5
T-3, L Superior	14	5	19	1	1	2	7.1	20.0	10.5
T-3, L Inferior	14	5	19	1	1	2	7.1	20.0	10.5
T-4, R Superior	15	5	20	1	1	2	6.7	20.0	10.0
T-4, R Inferior	12	8	20	0	1	1	0.0	12.5	5.0
T-4, L Superior	13	5	18	1	1	2	7.7	20.0	11.1
T-4, L Inferior	15	5	20	1	1	2	6.7	20.0	10.0
T-5, R Superior	11	8	19	0	1	1	0.0	12.5	5.3
T-5, R Inferior	13	8	21	0	1	1	0.0	12.5	4.8
T-5, L Superior	10	8	18	0	1	1	0.0	12.5	5.6
T-5, L Inferior	14	7	21	1	2	3	7.1	28.6	14.3
T-6, R Superior	14	6	20	2	2	4	14.3	33.3	20.0
T-6, R Inferior	14	7	21	1	2	3	7.1	28.6	14.3
T-6, L Superior	13	6	19	2	3	5	15.4	50.0	26.3
T-6, L Inferior	14	7	21	1	0	1	7.7	0.0	4.8
T-7, R Superior	14	5	19	1	1	2	7.1	20.0	10.5
T-7, R Inferior	14	6	20	1	2	3	7.1	33.3	15.0
T-7, L Superior	14	6	20	1	1	2	7.1	16.7	10.0
T-7, L Inferior	14	7	21	2	2	4	14.3	28.6	19.0
T-8, R Superior	12	4	16	1	1	2	8.3	25.0	12.5
T-8, R Inferior	11	5	16	0	0	0	0.0	0.0	0.0
T-8, L Superior	11	4	15	0	1	1	0.0	25.0	6.7
T-8, L Inferior	12	5	17	0	3	3	0.0	60.0	17.6
T-9, R Superior	13	8	21	1	1	2	7.7	12.5	9.5
T-9, R Inferior	13	8	21	1	1	2	7.7	12.5	9.5
T-9, L Superior	12	7	19	1	1	2	8.3	14.3	10.5
T-9, L Inferior	11	7	18	0	2	2	0.0	28.6	11.1
T-10, R Superior	10	7	17	0	2	2	0.0	28.6	11.8
T-10, R Inferior	11	6	17	2	2	4	18.2	33.3	23.5
T-10, L Superior	10	6	16	0	2	2	0.0	33.3	12.5
T-10, L Inferior	11	6	17	2	2	4	18.2	33.3	23.5
T-11, R Superior	11	2	13	1	2	3	9.1	100.0	23.1
T-11, R Inferior	11	5	16	0	2	2	0.0	40.0	12.5
T-11, L Superior	11	6	17	1	2	3	9.1	33.3	17.6
T-11, L Inferior	11	6	17	0	2	2	0.0	33.3	11.8
T-12, R Superior	12	6	18	1	1	2	8.3	16.7	11.1
T-12, R Inferior	12	6	18	1	1	2	8.3	16.7	11.1
T-12, L Superior	12	5	17	1	1	2	8.3	20.0	11.8
T-12, L Inferior	9	6	15	0	0	0	0.0	0.0	0.0
All									
R Superior	154	72	226	10	14	24	6.5	19.4	10.6
R Inferior	157	73	230	9	12	21	5.7	16.4	9.1
L Superior	149	69	218	9	14	23	6.0	20.3	10.6
L Inferior	166	80	246	9	15	24	5.4	18.8	9.8

TABLE 41

FREQUENCY OF OCCURRENCE OF ALL ARTHRITIC INVOLVEMENT ON THE LUMBAR ARTICULAR SURFACES

ARTICULAR SURFACE	*n* M.	*n* F.	*n* T.	NUMBER M.	NUMBER F.	NUMBER T.	PERCENTAGE M.	PERCENTAGE F.	PERCENTAGE T.
L-1, R Superior	13	7	20	0	1	1	0.0	14.3	5.0
L-1, R Inferior	12	7	19	0	3	3	0.0	42.9	15.7
L-1, L Superior	11	4	15	0	3	3	0.0	75.0	20.0
L-1, L Inferior	11	7	18	0	3	3	0.0	42.9	16.7
L-2, R Superior	10	6	16	0	2	2	0.0	33.3	12.5
L-2, R Inferior	9	5	14	0	1	1	0.0	20.0	7.1
L-2, L Superior	9	4	13	0	1	1	0.0	25.0	7.7
L-2, L Inferior	9	5	14	0	1	1	0.0	20.0	7.1
L-3, R Superior	9	5	14	0	2	2	0.0	40.0	14.3
L-3, R Inferior	8	5	13	0	1	1	0.0	20.0	7.7
L-3, L Superior	9	5	14	0	1	1	0.0	20.0	7.1
L-3, L Inferior	8	5	13	0	2	2	0.0	40.0	15.4
L-4, R Superior	6	5	11	1	2	3	16.7	40.0	27.3
L-4, R Inferior	6	4	10	1	2	3	16.7	50.0	30.0
L-4, L Superior	6	4	10	1	2	3	16.7	50.0	30.0
L-4, L Inferior	6	4	10	1	2	3	16.7	50.0	30.0
L-5, R Superior	6	6	12	2	3	5	33.3	50.0	41.7
L-5, R Inferior	6	6	12	1	2	3	16.7	33.3	25.0
L-5, L Superior	5	4	9	2	3	5	40.0	75.0	55.6
L-5, L Inferior	6	6	12	1	2	3	16.7	33.3	25.0
All lumbar									
R Superior	44	29	73	3	10	13	6.8	34.5	17.8
R Inferior	41	27	68	2	9	11	4.9	33.3	16.2
L Superior	40	21	61	3	10	13	7.5	47.6	21.3
L Inferior	40	27	67	2	10	12	5.0	37.0	17.9

TABLE 42

A COMPARISON OF LIVING (ca. 1920) AND PREHISTORIC TONGAN MEASUREMENTS

	MALE						FEMALE					
		(SULLIVAN)			(PIETRUSEWSKY)			(SULLIVAN)			(PIETRUSEWSKY)	
MEASUREMENT INDEX	*n*	MEAN (92-117)	S.D.	*n*	MEAN	S.D.	*n*	MEAN (88-97)	S.D.	*n*	MEAN	S.D.
Head length	117	191.0	6.9	13	183.1	7.9	97	184.1	6.47	5	172.6	4.2
Head width	117	154.8	4.3	12	143.0	10.0	97	150.0	5.1	4	133.5	7.4
Cephalic index	117	81.1	3.1	11	78.3	6.2	97	81.6	4.1	4	77.1	4.1
Min. frontal diameter	116	104.8	4.9	12	101.8	6.4	96	103.0	4.7	5	97.6	4.8
Bizygomatic	116	143.5	5.9	3	142.7	2.1	97	136.1	6.0	0	—	—
Zygomatico-frontal index	116	73.1	4.2	3	72.0	4.9	97	75.4	3.3	0	—	—
Bigonial	116	104.8	5.8	17	101.3	8.5	96	99.2	4.8	7	95.3	2.9
Corrected measurements												
Head length	117	180.0	6.9	13	183.1	7.9	97	173.1	6.5	5	172.6	4.2
Head width	117	143.8	4.3	12	143.0	10.0	97	139.0	5.1	4	133.5	7.4
Cephalic index	117	79.9	3.1*	11	78.3	6.2*	97	80.3	4.1*	4	77.1	4.1*
Min. frontal diameter	116	98.8	4.9	12	101.8	6.4	96	95.0	4.7	5	97.6	4.8
Bizygomatic	116	131.4	5.9	3	142.7	2.1	97	124.0	6.0	0	—	—
Zygomatico-frontal index	116	75.2	4.2*	3	72.0	4.9	97	76.6	3.3*	0	—	—
Bigonial	116	80.6† (94.8)**	5.8	17	101.3	8.5	96	75.0† (89.2)**	4.8	7	95.3	2.9

* approximate estimate of S.D.

† probably too low as measurement was taken differently by Sullivan

** a more reasonable estimate

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FLOWERING OF TARO, COLOCASIA ESCULENTA (L.) SCHOTT, ARACEAE, IN NEW ZEALAND

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Abstract. The flowering of taro, *Colocasia esculenta* (L.) Schott, in New Zealand is recorded. The male flowers lack pollen. So far, ripe fruits have not been found.

Colenso (1868, p. 30) recorded that taro in New Zealand "very rarely flowers and it has never been known to produce seed." Best (1931, p. 7) mentioned that the Rev. T. G. Hammond had seen a flowering specimen of taro at Hokianga.

Flowering specimens, collected in New Zealand and preserved in the Cheeseman Herbarium of the Auckland Institute and Museum, are listed in the following table:

Column 1: Herbarium number; 2: Locality; 3: Collector; 4 - 9 Measurements of length: 4: Spathe tube; 5: Female flowers; 6: Sterile flowers; 7: Male flowers; 8: Sterile appendange; 9: Complete spadix. All measurements are in cm.

1.	2.	3.	4.	5.	6.	7.	8.	9.
477	Waimate, Bay of Islands, February 1895	T. F. Cheeseman	15.5	An empty spathe				
5476	Kaitaia, April 1921	R. H. Matthews	22.5	3.1	2.3	4.9	4.6	14.9
44326	Met. station, Raoul Island, June 1956	R. C. Cooper	16.4	1.8	1.2	2.5	.5	6.0
70451	Garden, 7 Edmund Street, Auckland, April 1962	A. T. Pycroft	26.6	3.0	2.0	6.5	2.3	13.8
90327	Ngaire Bay, south of Whangaroa, Dec. 1963	Miss A. Leahy	24.1	1.9	2.5	2.4	2.3	9.1
90328	Kerikeri beach, Dec. 1963	Miss A. Leahy	22.8	5.5	—	1.7	2.0	9.2
90329	Kerikeri beach, Dec. 1963	Miss A. Leahy	26.2	5.6	—	2.5	.6	8.7
90330	Kerikeri beach, Dec. 1963	Miss A. Leahy	25.6	5.5	—	2.6	.6	8.7
118571	Whareora, Whangarei, September 1968	J. C. Nicholson	18.1	3.8	1.1	3.7	3.2	11.8

Colocasia esculenta (L.) Schott has two botanical varieties:

var *esculenta* (formerly *typica*), in which the sterile appendage of the spadix is shorter in length than the male inflorescence. This variety has also been defined as that in which the sterile appendage is short and is freed when the spathe tube opens.

var. *antiquorum* (Schott) Hubbard & Rehder, in which the sterile appendage is equal to or greater than the length of the male flowers. This variety has also been defined as that in which the appendage is

longer, and remains caught in the terminal part of the spathe when the tube opens.

The two kinds of spadix, with the spathe removed, are shown in Figs. 1 & 2.

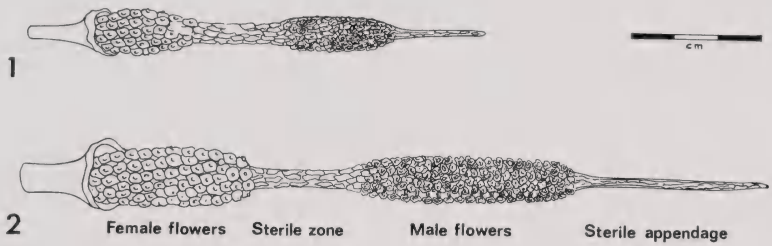


FIG. 1—Spadix of *Colocasia esculenta* (L.) Schott var. *esculenta* with the spathe removed.

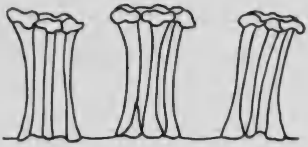
FIG. 2—Spadix of *Colocasia esculenta* (L.) Schott var. *antiquorum* (Schott) Hubbard & Rehder, with the spathe removed.

From the measurements, it seems that number 44326, collected near the meteorological station on Raoul Island in June 1956 by R. C. Cooper; 70451, collected at 7 Edmund Street, Auckland, in April 1962 by A. T. Pycroft; and 90327-90330, collected at Ngaire Bay and Kerikeri in December, 1963, by Miss A. Leahy; are var. *esculenta*. Number 44326 may be a recent introduction to Raoul Island; Mr. Pycroft's plant was obtained about 1909 from Waikare, Bay of Islands, and is reputed to be one of the clones grown by the Maori people in the past; the taros collected by Miss Leahy at Ngaire Bay and Kerikeri grow wild on the coast and may be relics of past Maori plantings, although a local resident said that the tubers are very bitter and are not eaten.

From the measurements, it seems that number 5476, collected at Kaitaia in April 1921 by R. H. Matthews; and number 118571, grown at Whareora in September 1968 by J. C. Nicholson; are var. *antiquorum*. Unfortunately, nothing is known of the history of Mr. Matthews' taro. Mr. Nicholson's was obtained from "a Maori lady".

Spadices numbered 90328, 90329 and 90330, collected by Miss Leahy near Kerikeri, lack a sterile zone between the male and female flowers. The synangia or fused anthers of male flowers of numbers 44326, 70451, 90327-90330 (var. *esculenta*), and 5476 and 118571 (var. *antiquorum*) are 1-1.5 mm tall, and thin (Fig. 3). There are a few grains in the synangia of 118571, but the others lack pollen. Synangia from a spadix collected in Fiji and numbered 11169 in the Herbarium, are 1 mm tall, thicker, and crowded with pollen grains. They are illustrated for comparison in Fig. 4.

In June 1956 the writer collected fruiting specimens of taros growing wild in a seepage of fresh water at Lava Point, Raoul Island. These are numbered 44359 in the Herbarium. In all specimens the portion of the spathe above the constriction has opened and withered away, but the fruits on the spadix are stunted and lack seeds. Another fruiting specimen, numbered 71737, was obtained from Mr. Pycroft's plant in May, 1962.



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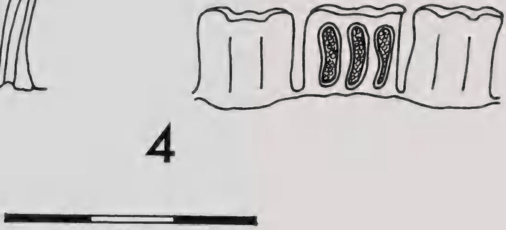

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FIG. 3—Synangia or fused anthers of *Colocasia esculenta* (L.) Schott var. *esculenta,* collected in New Zealand.

FIG. 4—Synangia of *C. esculenta* var. *esculenta,* collected in Fiji.

Again, although the spathe opened and withered, the fruits on the spadix are dwarfed and do not contain seeds.

The flowering of Mr. Pycroft's taro in April 1962 was described in several newspapers, and 11 readers wrote or telephoned to give information regarding the flowering of other taro plants. All were asked to look for ripe fruits, without success.

In December 1963 when Miss Leahy collected a number of taros at Ngaire Beach and Kerikeri, she brought one in bud to the Museum and this plant was grown in the Museum courtyard. The spadix developed to anthesis, but it withered without producing seeds. The spadix is numbered 90326 in the Herbarium.

In March 1964 Mrs. T. Harris of Henderson forwarded a withered flower from a taro in her garden. This specimen is numbered 98108 in the Herbarium. Mrs. Harris advised that the plant was from a clone formerly grown by the Maori people. The fruits on the spadix are stunted and the seeds have not developed. Again, in April 1967 Mrs. Harris forwarded a fruiting spadix from another taro in her garden. She advised that this second plant was from a Samoan clone and had been grown for three years. The fruits are small and lack ripe seeds.

Mr. Pycroft's plant has been divided in the past to provide offshoots for other gardeners, and one of these offshoots flowered in February 1968. Mr. Ralph Pycroft collected two spadices when spathes and stalks withered, and presented them to the Museum. They are numbered 118208 and 118209 in the Herbarium. Although the ovaries enlarged, the ovules have not ripened. One of these spadices is shown in Fig. 5, surrounded by the lower portion of the spathe.

In September 1968 Mr. J. C. Nicholson sent a fruiting spadix from his plant at Whareora. Again, the fruits are small and the ovules have not ripened.

To sum up these results, fruiting spadices numbered 44359, 71737, 90326, 118208, 118209 (all var. *esculenta*), 118571 (var. *antiquorum*), and 98108 (var. not determined), from New Zealand sources, have small

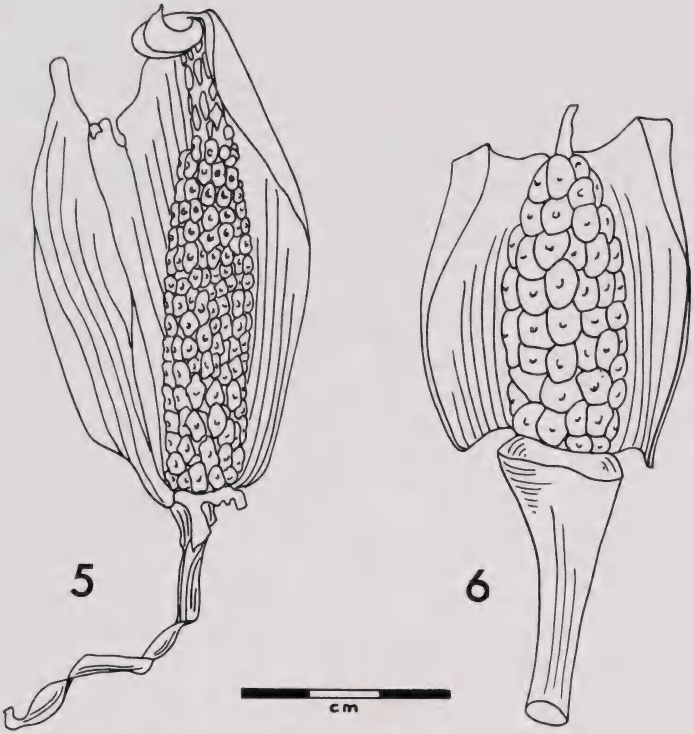

FIG. 5—Fruit of *Colocasia esculenta* (L.) Schott var. *esculenta,* collected by Mr. Ralph Pycroft at Auckland, New Zealand.

FIG. 6—Fruit of *C. esculenta* var. *esculenta* (?), collected by Dr. J. Barrau at the Wosi River, near Manokwari, Netherlands New Guinea, now West Irian.

fruits, and white ovules (when fresh). Spathes and stalks wither, and the fruits fail to ripen seeds. A fruiting specimen from New Guinea that yielded seeds is shown for comparison in Fig. 6.

I am indebted to Miss A. Leahy, Mrs. T. Harris, Dr. J. Barrau, Mr. and Mrs. A. T. Pycroft, Mr. Ralph Pycroft and Mr. J. C. Nicholson for specimens, and to Miss J. H. Goulding for drawings.

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OUTGROWTHS OF KAURI, AGATHIS AUSTRALIS SALISB., ARAUCARIACEAE, IN THE AUCKLAND INSTITUTE AND MUSEUM, NEW ZEALAND

R. C. Cooper
Auckland Institute and Museum

Abstract. "Lacewood" and "knobby wooden curios" produced by the New Zealand kauri tree, *Agathis australis* Salisb., are described. Correspondents advise that "lacewood" is formed following damage to the trunk and resembles a flattened branch enclosed within the bark. "Curios" are aerial roots cleaned of their bark.

In the Cheeseman Herbarium of the Auckland Institute and Museum there are four kauri outgrowths, catalogued:

1. Piece of lacewood, 46 x 24 x 2 cm, presented by Mr. A. E. Brookes, 1st June 1950. Fig. 1.
2. Knobby wooden curio, 60 x 18 x 14 cm, possibly from the Whitford district, presented by Mr. R. C. H. Hensen, October 1965. Fig. 2.
3. Knobby wooden curio, 52 x 17 x 12 cm, possibly from the Whitford district, presented by Mr. R. C. H. Hensen, October 1965.
4. Knobby wooden curio, 48 x 28 x 24 cm, possibly from the Kumeu district, presented by Mr. A. Cates, 21st March 1966. Fig. 3.

The only illustrations of outgrowths of kauri trees seem to be two paintings by C. Blomfield, one dated 1920, the other undated, presented to the Museum by Mrs. E. S. Blomfield in June 1943. One is shown in Fig. 4.

As there is little information regarding these growths in the literature on the kauri, *The New Zealand Herald* newspaper kindly published photographs of two of them. Readers were asked for information, and the following notes have been made from the replies received.

Kauri Lacewood

Mr. C. Hutly of Awanui wrote that lacework patterns were found under the bark of kauri trees that had fractured.

Mr. R. Fitzwilliam of Glenfield wrote that when milling kauri trees damaged by fire at Redvale near Albany, he obtained a piece of lacewood 10 to 12 feet long. He found it between two layers of bark inside a bulge on the trunk. It grew upward like a branch, but had not broken through

FIG. 1—Piece of kauri lacewood, 46 x 24 cm, presented by Mr. A. E. Brookes.

the outer layer. Lacewood was not uncommon in trees that had been damaged by fire.

Miss K. Spragg of Auckland advised that, in the 1920s, near their property in the Waitakere Ranges, her father cut a specimen of lacewood from a kauri tree that had been damaged by fire.

KNOBBY WOODEN CURIOS

Mr. C. Hutly of Awanui wrote that he had been told that these growths

were found in the heads of kauri trees. Possibly they developed where young shoots had been damaged by frost, wind, or insects.

Mr. T. C. Millar of Rawene wrote that most Hokianga homes had specimens 70 years ago. The growths were found on the trunks of kauri trees. When the trees were milled, the growths were cut off, and the bushmen took them back to camp and cleaned off the bark. It was an interesting hobby cutting away the bark to expose the wooden knobs.

FIG. 2—Outgrowth of kauri, 60 cm high, presented by Mr. R. C. H. Hensen.

Mr. R. Winger advised that he had eight specimens in his Sawmill Museum at Kaikohe. They were not found on the trunk or branches of kauri, but grew only from the roots. All his specimens were obtained from the roots of trees that grew in swampy ground and had fallen or blown over.

Mr. J. P. Church of Whangarei wrote that the growths were known to bushmen as "curios", and were aerial roots. About six miles from the

FIG. 3—Outgrowth of kauri, 48 cm high, presented by Mr. A. Cates.

Fig. 4—Painting of a kauri tree, by Mr. C. Blomfield.

south end of the Waipoua Forest there was a kauri tree alongside the road with several growths near the ground. Farther on, near the Tarahoka clearing, there was a kauri on the west side of the road which had enough growths on it to fill a dray. Mr. Church was in charge of road building there in 1927-28. Bushmen boiled or steamed the growths so that the bark would peel easily. Being of the sappiest of sap wood, they were prone to borer.

Mr. F. S. Holman of Whangarei advised that the growths were caused by dense masses of plants growing against the trunk of the kauri. Sometimes they developed inside hollow trees. At one time the little knobs were sought by cabinetmakers for veneers; when cut open the grain of the knob resembled the tightly packed petals of a rosebud.

Mr. E. Edge of Auckland presented a photograph of a large specimen collected at Kaimarama, near Whitianga, in 1913. He found it on a kauri tree where a rata vine (*Metrosideros sp.*) had injured the trunk. The growth had formed above the vine, and grew down about three feet. It was four feet in width, covered in bark, and weighed more than 1 cwt. Removal of the bark with a knife took a long time.

Mr. A. F. Hicks of Auckland wrote that the growths were known as "kauri tree flowers". The bark peeled off quite easily when they were green. Several correspondents advised that there are specimens in the Whangarei City Council Museum and the Waipu Pioneers' Memorial Museum. Finally, Mr. F. Whittaker of Oratia showed the writer a growth on a young kauri tree. It appeared to be composed of roots. It had formed on the trunk, about 1 metre from the ground, some 30 years ago, where a side shoot branched off.

I am indebted to *The New Zealand Herald* newspaper for publishing photographs of the growths; to many correspondents for interesting replies; and to Mr. Ian McLaren for photographs.

ADDITIONAL REMARKS TO THE NEW ZEALAND PSEUDOSCORPIONIDEA

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Abstract. Species are recorded from New Zealand, nearby islands, and the subantarctic Antipodes Islands. New species of *Nesidiochernes* and *Apatochernes* are described; *Maorichthonius mortenseni* Chamb. is redescribed.

Some small collections of Pseudoscorpionidea from New Zealand, White Island, Three Kings Islands, and the subantarctic Antipodes Islands, submitted to me by Mr. K. A. J. Wise, Auckland Museum, and Dr. Malcolm Luxton, Soil Bureau, Lower Hutt, contain the following species.

NEW ZEALAND

Austrochthonius inversus Beier

Mokohinau Is.: forest, ex leaf mould, 23.VIII.1935, R. A. Harrison (new record).

Maorichthonius mortenseni Chamberlin

Leigh (see re-description below).

Euryolpium (Antiolpium) zealandiense (Hoff.)

Mokohinau Is.: forest, ex leaf mould, 23.VIII.1935, R. A. Harrison (new record).

Synsphyronus (Maorigarypus) melanochelatus (Chamberlin)

Taupo Co.: Taupo, in house, 14.III.1962, J. W. Dee.

Bay of Islands Co.: Paihia, —.V.1953, W. Delph.

Lamprochernes savignyi (Simon)

Waipa Co.: Te Awamutu, phoretic on fly, 16.IV.1958, B. Eversfield (new record).

Thalassochernes pallipes (White)

Whangaroa Co.: Tauranga Bay, Butterfly valley, nikau leaf litter debris, 28.IX.1966, Wise.

Whangarei Co.: Hikurangi, Waro Res., beaten from *Freycinetia,* 10.VIII,1966, Wise.

Waitemata Co.: Huia, —X.1947, Nicholls; Titirangi, Wood Bay, 1958, J. Pollard.

Nesidiochernes scutulatus n.sp.

Hamilton (see description below).

Apatochernes obrieni Beier

Mokohinau Is.: forest, ex leaf mould, 23.VIII.1935, R. A. Harrison (new record).

Rec. Auck Inst. Mus. 6 (4-6): 413-418 March 14th 1969.

Apatochernes cheliferoides Beier

Hobson Co.: North Wairoa, Glinks Gully, —XII.1956, Mrs. E. Mellor.

Rodney Co.: N. of Waiwera, forest remnant, 2.IX.1966, Wise.

Waitemata Co.: Cornwallis, under sack on beach, 30.I.1967, S. Charteris.

Auckland: Epsom, in house, 22.VII.1952, B. W. Knight.

Coromandel Co.: Whangapoua, —.I.1955, M. McCallum.

Buller Co.: N. Karamea, 10.III.1936, C. E. Clarke collection.

WHITE ISLAND

Austrochthonius inversus Beier

Ohauora: many specimens, 6.XII.1966, Wise (new record).

Ideobisium peregrinum Chamberlin

Ohauora: several specimens, 6.XII.1966, Wise (new record).

Euryolpium (Antiolpium) zealandiense (Hoff.)

Ohauora: several specimens, 6.XII.1966, Wise (new record).

THREE KINGS ISLANDS

Apatochernes turbotti n.sp.

South-West I. (see description below).

Philomaoria novazealandica Chamberlin

Great I.: —.XI. —.XII.1945, Arbutus Exped.; Depot Valley, sedge litter, 20.IV.1946, E. G. Turbott; N.W. Bay, very dry under ngaio and karaka at side of *Placostylus bollonsi caperatus* colony; litter sample 1, 15.I.1951, Turbott; Tasman Valley, on rock, 31.XII.1952, J. S. Edwards; in ngaio seeds, 20.XII.1952, Edwards; the saddle, beaten ex kanuka scrub, 2.I.1953, Edwards; sweepings from *Colensoa*, quadrat 2, 1.I.1953, Edwards; in camp, on wood, 5.I.1953, Edwards.

ANTIPODES ISLANDS

Apatochernes antarcticus Beier

Above Ringdove Bay: beating tussock of plateau, 6.XI.1950, E. G. Turbott (new record).

DESCRIPTIONS

Maorichthonius mortenseni Chamberlin (Fig. 1)

Maorichthonius mortenseni Chamberlin, 1925, *Vidensk. Medd. Dansk naturh. Foren.* 81: 335, Fig. 1.

Carapace, chelicerae, and pedipalps rather dark brown, abdominal tergites paler brownish. Carapace a little broader than long, slightly narrowed basally, smooth but weakly reticulate in the hind corners, with 18 rather strong bristles and a short preocular bristle, the two median anterior border bristles close together, the 4 posterior border bristles of same length; epistomal process large, very prominent, bluntly triangular, scarcely denticulate. Anterior eyes vaulted, posterior ones flat. Chaetotaxy of abdominal tergites: ♂ 6-7-8-17-18-19-20-20-18-10-4; ♀ 6-6-8-12-14-16-17-18-16-12-4; the bristles are all together long and strong, and stand in a somewhat irregular transverse row; the lateral bristles of ultimate tergite are long tactile bristles. Abdominal sternites each with a row of mostly 15 bristles, which are a little shorter than the tergal ones. Chelicerae big, longer than carapace, with 5 palm-bristles, the

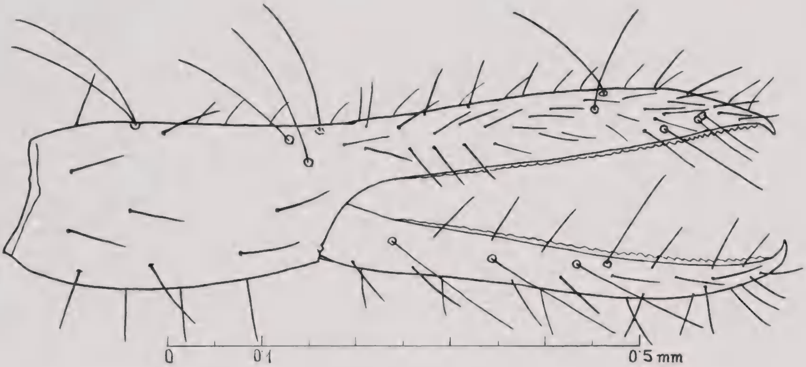

FIG. 1—*Maorichthonius mortenseni* Chamb. ♀, right chela laterally.

basal bristle short, the subbasal one about half as long as *LS*. Fixed cheliceral finger with few blunt and spaced teeth, movable one finely denticulate, with flat spinneret tubercle in both sexes. Pedipalps relatively short. Femur a little longer than carapace. Chela 4.5 times (♀) to 5 times (♂), hand 1.8 times (♀) to 2 times (♂) longer than broad, with a single moderately long pike-bristle medially at the base of the fingers; tactile setae *ib* and *isb* proximad of the middle. Fingers 1.5 times (♀) to 1.6 times (♂) longer than hand, densely serrate-dentate, the teeth relatively small, very small in the proximal half of finger; tactile seta *eb* distad from *esb*, *st* of movable finger 2½ times at least farther from *sb* than from *t*, *sb* a little closer to *st* than to *b*. Medial corner of coxa of first leg with a long and thick digitate process without bristles. Coxa of second leg medioorally instead of coxal spines with several short rows of 5 to 6 finest microchaetes, which stand partly on chitinous ridges (overlooked by Chamberlin). Intercoxal tubercle absent. Legs very strongly bristly, femora with a row of long dorsal bristles. Male genital operculum orally with 4 strong bristles mutually, caudally with 4 rather fine marginal bristles and 8 strong lateral bristles, and with 4 internal bristles in large areoles.

Body, length ♂ 1.6 mm, ♀ 1.8 mm; carapace, length ♂ 0.51 mm, ♀ 0.50 mm, breadth ♂ 0.56 mm, ♀ 0.55 mm; pedipalps: femur, length ♂ 0.56 mm, ♀ 0.52 mm; hand, length ♂ ♀ 0.33 mm, breadth ♂ 0.16 mm, ♀ 0.18 mm; fingers, length ♂ 0.52 mm, ♀ 0.50 mm.

MATERIAL. 1 ♂, 4 ♀ ♀, 1 tritonymph, 1 deutonymph, New Zealand, North Island, Leigh, from rock crevices on the seashore, *Chamaesipho columna* zone, 23.II.1967, M. Luxton.

The measurements of pedipalps given by Chamberlin, 1925, are erroneously about twice as in reality. I thank Prof. David R. Malcolm, Portland, for that confirmation on the base of the paratypes.

Maorichthonius is related to the genus *Morikawia* but differs from it principally by the plurisetose abdominal tergites and by the presence of several rows of finest microchaetes instead of coxal spines.

Nesidiochernes scutulatus n.sp. (Fig. 2)

Carapace a little longer than broad posteriorly, very densely and mosaic-shaped granulate, the granulation finer in the middle of the metazona, coarsely but shallowly laterally; the carapace is dark brown anteriorly and laterally, paler beside the middle of pro- and metazona, whitish with a dark median spot in the metazona; both transverse furrows well developed, granulate, the subbasal one not sharply bordered

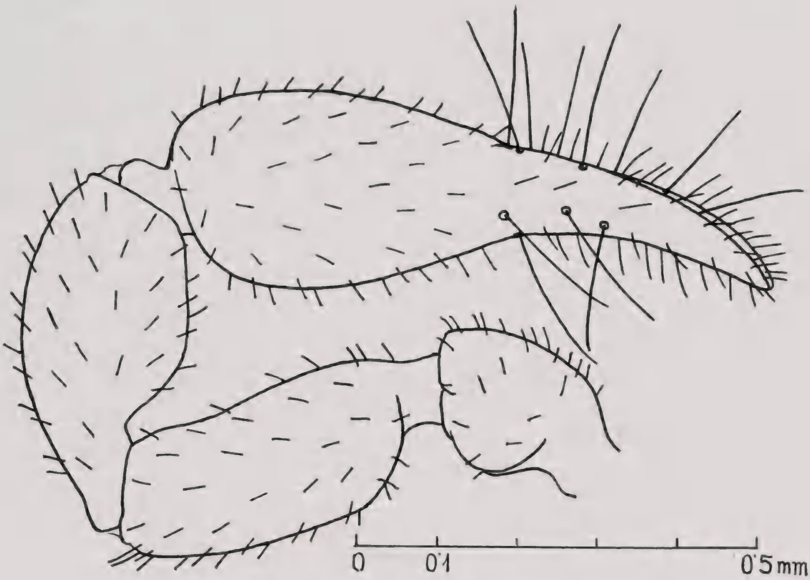

FIG. 2—*Nesidiochernes scutulatus* n.sp. ♀, left pedipalp.

and scarcely ⅓ closer to the posterior border than to the anterior furrow. Eye spots wanting. Abdominal tergites all broadly divided except the ultimate, very densely granulate; half tergites mostly with 7 posterior border bristles and 1 lateral border bristle, those of 10th segment with 3 posterior border bristles, 1 lateral border, 1 median border, and 1 discal bristle; ultimate tergite with 6 border bristles, 2 discal bristles, and 2 moderately long lateral tactile bristles; the bristles are pin like, dentate distally, not clavate. Abdominal tergites pale brownish; each half tergite in the proximal half with a large paler transverse spot; the third segment with 2 large paler transverse spots occupying almost the whole tergite and appearing as a pale transverse band; on the posterior segments is this spot divided into several smaller spots of unequal size, and the ultimate tergite has 8 small spots forming a transverse row. Palm of chelicera with 6 bristles. Galea with short lateral branches. Pedipalps coarsely granulate medially, with the vestitural bristles stiff, one-sided dentate, not clavate. Trochanteral tubercle round. Femur very abruptly pedicellate, 2.4 times, tibia 2.2 times, hand 2 times, chela with pedicel 3.3 times, without pedicel 3 times longer than broad; the hand is, therefore, relatively narrow. Fingers about as long as hand without pedicel, with accessory teeth well developed. Tactile setae *est, ist,* and *it* of fixed finger extraordinarily proximad, *it* still in the proximal half of finger and 1½ times farther from finger-top than from *isb, ist* somewhat closer to *it* than to *isb;* tactile seta *t* of movable finger a little distad of the middle of the finger, *st* about half-way between *sb* and *t*. Hind tarsi without tactile bristle.

Body, length ♀ 2 mm; carapace, length 0.67 mm, breadth 0.55 mm; pedipalps: femur, length 0.44 mm, breadth 0.18 mm, tibia, length 0.44 mm, breadth 0.20 mm, hand, length 0.48 mm, breadth 0.24 mm, fingers, length 0.38 mm.

HOLOTYPE. 1 ♀, New Zealand, North Island, Hamilton, R. Nielson (Auckland Museum).

The new species differs very well from the related *N. zealandicus* Beier by the distribution of the pale spots on the top side, by the narrow palpal hand, longer fingers, and by the tactile seta *it* of the fixed finger standing much more proximad.

Apatochernes turbotti n.sp. (Fig. 3)

Uniformly reddish brown, meso- and metazona of carapace only a little paler. Integument extraordinarily densely and finely granulate, grainlets of abdominal tergites somewhat transverse. Pleural membrane longitudinally striate-granulate. Vestitural bristles mostly short and moderately clavate. Carapace 1.2 times in the male, but only a little longer than broad posteriorly in the female, with two distinct but not very deep transverse furrows, the subbasal one twice as far from the anterior furrow as from the posterior margin. Eye spots wanting. Abdominal tergites divided except the ultimate; half tergites of the two anterior segments each with 5, the following with 6 (♂) to 7 (♀) posterior border bristles, onwards from 4th segment also with 1 lateral border bristle; half tergites of 10th segment with 2 posterior border bristles, 1 median border, 1 lateral border, and 1 discal bristle; 11th tergite with 6

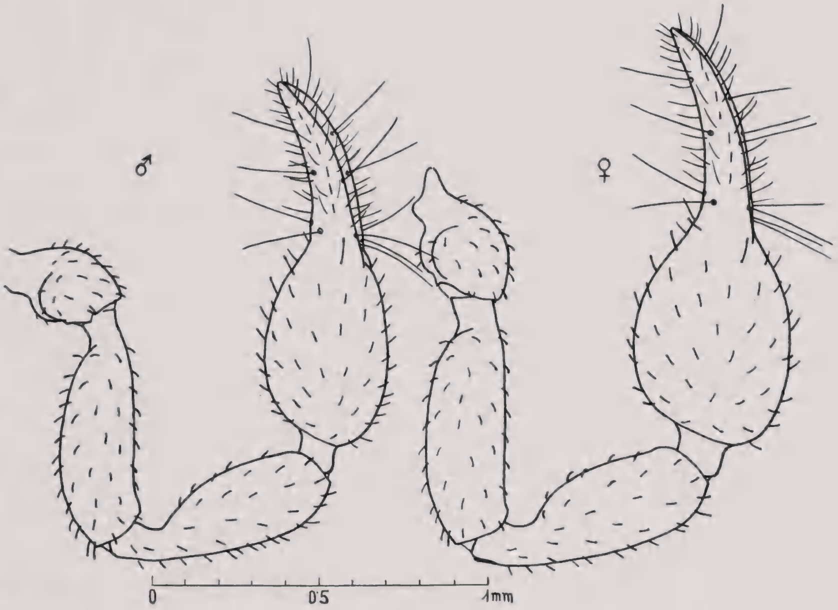

FIG. 3—*Apatochernes turbotti* n.sp. Right pedipalp of ♂ and ♀.

border bristles and 2 discal bristles altogether, the discal and lateral border bristles elongate and distinctly clavate; bristles of the posterior segments successively longer. Half sternites mostly with 8, those of 10th segment with 6 border bristles; ultimate sternite with 4 (♂) to 6 (♀) border bristles and 2 discal bristles, the lateral border bristles elongate and slightly clavate. Palm of chelicera with 5 bristles, *SB* only dentate. Galea of the male almost simple, of the female with several terminal branches. Pedipalps moderately slender, with the medial and dorsal bristles short and distinctly clavate, and with the lateral and ventral bristles somewhat longer and mostly dentate only; mediodistal bristles of the hand elongate. Trochanteral tubercles round. Femur only very abruptly pedicellate, broadest distally, 3.2 times, tibia 2.8 times, hand 1.5 times (♀) to 1.8 times (♂), chela with pedicel 2.8 times (♀) to 3.3 times (♂), without pedicel 2.6 to 3 times longer than broad. Fingers as long as hand with pedicel (♂) or (♀) a little longer, each with about 60 teeth; fixed finger laterally with 8, medially with 3, movable one laterally with 9, medially with 2, accessory teeth. Disposition of tactile setae regular. Hind tarsus without tactile bristle.

Body, length ♂ 2 mm, ♀ 2.6 mm; carapace, length ♂ 0.76 mm, ♀ 0.86 mm, breadth ♂ 0.63 mm, ♀ 0.80 mm; pedipalps: ♂ femur, length 0.70 mm, breadth 0.22 mm, tibia, length 0.68 mm, breadth 0.24 mm, hand, length 0.68 mm, breadth 0.37 mm, fingers, length 0.58 mm; ♀ femur, length 0.74 mm, breadth 0.23 mm, tibia, length 0.73 mm, breadth 0.26 mm, hand, length 0.75 mm, breadth 0.47 mm, fingers, length 0.65 mm.

HOLOTYPE. 1 ♂, Three Kings Islands, South-West I., half-way down N.E. slope, karaka and puka in scrub, leaf litter sample 2, 13.I.1951, E. G. Turbott (Auckland Museum).

PARATYPES. 5 ♂ ♂, 1 ♀, from same locality (Auckland Museum and Museum Vienna).

The new species is distinguishable from the other species with 5 cheliceral palm-bristles (*pterodromae* and *antarcticus*) by the abdominal tergites uniformly reddish brown, the posterior transverse furrow of carapace much more basally, the pedipalps slenderer, the mediodistal bristles of palpal hand elongate, and the tactile seta *it* of the fixed finger farther distally. Very similar habitually to *A. obrieni* Beier, from which it differs by 5 cheliceral palm-bristles, unicolored abdominal tergites, shorter and stronger clavate vestitural bristles, longer palpal fingers, and by the subbasal transverse furrow of carapace much farther from anterior furrow.

A NEW CERCARIA FROM PHELUSSA FULMINATA (HUTTON, 1883), (PULMONATA: ENDODONTIDAE)

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University of Canterbury, Christchurch

Abstract. A new distomous cercaria is described and the possible definitive host is discussed.

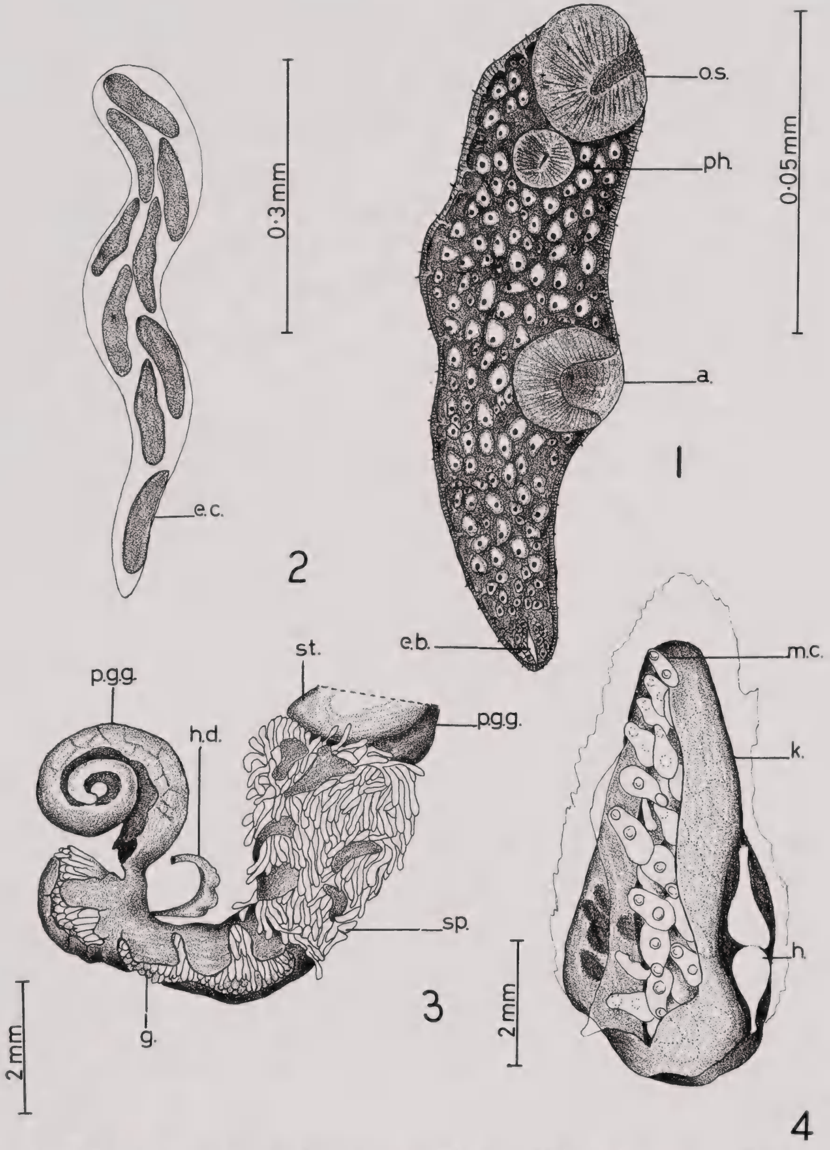
The only other larval trematode reported from New Zealand endodonts was a dicrocoelid recorded from *Allodiscus godeti* Suter, 1891 (Suter 1891). This was incompletely described and poorly figured. A new species of *Paradistomum* Kossack, 1910 (Dicrocoelidae) has been described (Allison and Climo, 1969) from the gall-bladder of *Hoplodactylus pacificus* (Gray) (Gekkonidae) and this could be the adult stage of the cercaria recorded by Suter.

Class	TREMATODA
Subclass	DIGENEA
Family	BRACHYLAEMIDAE Joyeux et Foley, 1930
Subfamily	BRACHYLAEMINAE Joyeux et Foley, 1930

Cercaria fulminata n.sp. (Figs. 1-7)

Host and Type Locality. The molluscan host is a large endodont land snail, approximately 12 mm in diameter, endemic to Stewart Island and its off-shore islets. The cercaria is known from a single specimen of *Phelussa fulminata* (Hutton) collected from Codfish Island by P. M. Johns (Department of Zoology, University of Canterbury) in 1964. The parasitized snail was a large mature specimen with a major diameter of 13 mm. Several juvenile snails from the same locality were dissected, but were found uninfected.

Location. Most of the apical whorls of the snail were heavily infected by sporocysts. A large mass of sporocysts extended from the gonads to the stomach and an equally large mass was situated in the posterior gut gland immediately overlying the albumen gland. The posterior gut gland and the albumen gland were atrophied to a fraction of their normal size (Fig. 3). One hundred and eighty-nine cercariae, the largest measuring 1 mm in length, were extracted from the kidney (Fig. 4). The internal folds of the kidney were much reduced, and the kidney wall was ruptured in one place, allowing nineteen cercariae to enter the mantle cavity.



FIGS. 1-4—*Cercaria fulminata* n.sp. from *Phelussa fulminata* (Hutton, 1883).
1. Immature cercaria. 2. Sporocyst. 3. Sporocysts in posterior gut gland. 4. Infected kidney.

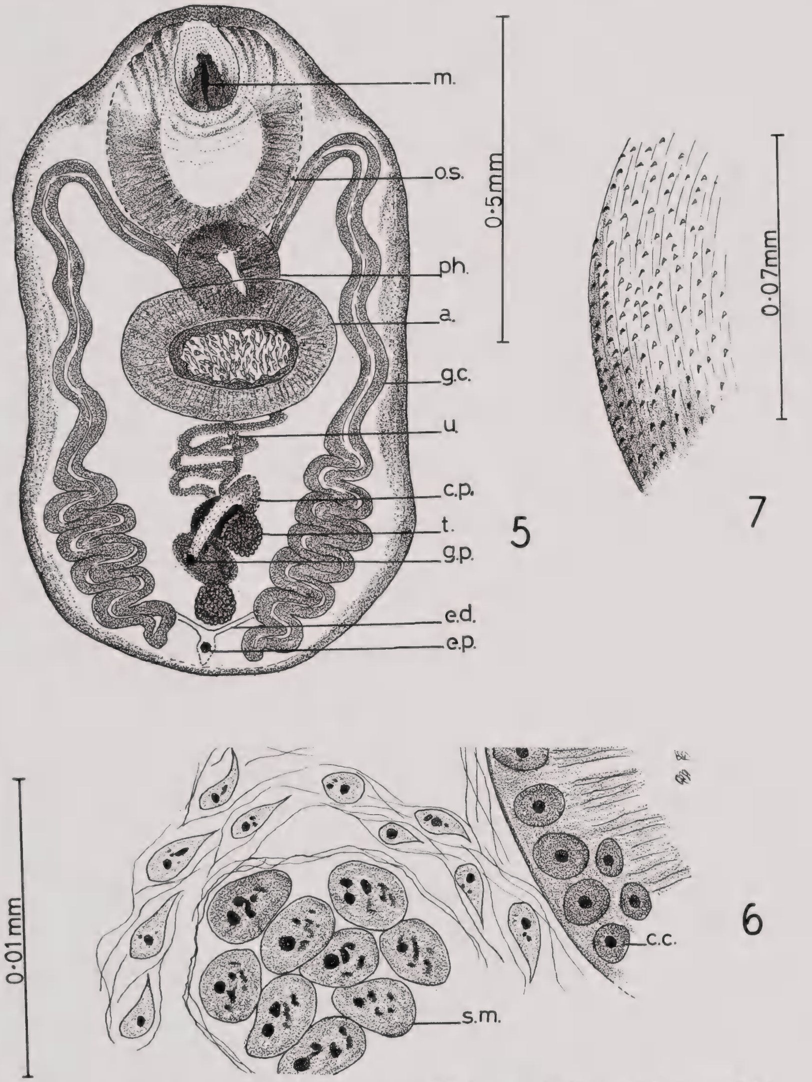
a.—acetabulum; e.b.—excretory bladder; e.c.—embryonic cercariae; g.—gonads; h.—heart; h.d.—hermaphroditic duct; k.—kidney; m.c.—mature cercaria; o.s.—oral sucker; p.g.g.—posterior gut gland; ph.—pharynx; sp.—sporocysts; st.—stomach.

DESCRIPTION OF LARVAL STAGES

Sporocysts. Elongate, sausage-like structures, tapering at one end and measuring between 0.5 and 0.7 mm in length (Fig. 2). Within the sporocysts were 6-12 embryonic cercariae.

Embryonic cercariae. Length 0.1 mm. The only recognisable organs are two suckers, a pharynx and excretory bladder. Most of the body is filled with large, undifferentiated cells, smaller around the excretory bladder (Fig. 1). Oral sucker large, terminal. Pharynx strongly developed, approximately one-fifth the size of oral sucker. Acetabulum strongly developed, nearly equal in size to oral sucker, its position varying slightly but approximately equatorial. Excretory bladder situated at posterior extremity. Cuticle striated and sparsely spinose.

Mature cercariae much larger than embryonic cercariae (1 mm in length). In all specimens examined, the oral sucker was invaginated to some extent, probably due



FIGS. 5-7—*Cercaria fulminata* n.sp. from *Phelussa fulminata* (Hutton, 1883). 5. Mature cercaria. 6. Sperm mother cells. 7. Surface of mature cercaria.

a.—acetabulum; c.c.—cells of gut caeca; c.p.—cirrus sac primordium; e.d.—excretory duct; e.p.—excretory pore; g.c.—gut caeca; g.p.—gonopore; m.—mouth; o.s.—oral sucker; ph.—pharynx; s.m.—sperm mother cell; t.—testis; u.—uterus.

to fixation. In life, the cercariae are probably elongate-sole-shaped animals, but when fixed contract assuming a roughly rectangular form, narrowest in the equatorial region. Oral sucker immediately subterminal, its greatest diameter approximately one-quarter of total length. As in embryonic cercariae, pharynx well developed and about one-fifth the size of the oral sucker. Acetabulum about three-quarters the size of the oral sucker, flattened antero-posteriorly and approximately equatorial; its anterior border overlying the pharynx. Gut caeca extend antero-laterally directly from the pharynx and then extend posteriorly (Fig. 5). Caeca slightly sinuous for about two-thirds of their length, but become strongly sinuous posterior to the acetabulum. (The degree of sinuosity has been used as a character for generic diagnosis, but it is impossible to say how much of the sinuosity in the animals here described is contraction due to fixation.) Caeca terminate opposite excretory bladder. The right caecum tends to be longer. Only reproductive primordia were recognisable. Two testes arranged obliquely in the posterior quarter of the animal, the posterior on the midline immediately anterior to the bifurcation of the excretory bladder and the anterior testis one testis width forward and to the right of the midline. (The testes were at the sperm mother cell stage, Fig. 6.) The gonopore opens just to the left of the midline between testes, and from it the cirrus sac primordium can be traced antero-laterally to a point just anterior to the anterior testis. Between the testes, and ventral to the cirrus sac primordium are groups of cells, probably the primordia of the rest of the glandular structures associated with the reproductive system. In some specimens, uterine coils were visible between the reproductive glands and the acetabulum but no eggs were present. Excretory bladder small, opening subterminally on the midline opposite the terminations of the gut caeca. The bladder bifurcates into two excretory ducts just posterior to the posterior testis, the ducts running antero-laterally, dorsal to the gut caeca. Surface of cercaria strongly spinose (Fig. 7), cuticular spines more sparse and shorter at posterior end of animal.

Type material. Holotype, paratypes and serial sections of mature cercariae from *Phelussa fulminata* (Hutton) collected on Codfish Island, 13 August 1964. The type material has been deposited in the Auckland Institute and Museum.

Discussion

While the cercaria readily keys to the subfamily Brachylaeminae (Yamaguti, 1958) it cannot be placed in any of the three genera listed (p. 675) because of the immature reproductive system.

The cercaria are essentially immature flukes and have no visible modifications for survival outside the host snail. It seems probable that the definitive host is infected passively by ingestion of infected snails. There have been no members of the above subfamily recorded from reptiles and it appears most likely that the definitive host is a bird, since this group of parasites is commonly found in birds. It is possible that the Stewart Island weka, *Gallirallus australis scotti* (Ogilvie-Grant) is the definitive host since it is a ground feeding bird known to eat land snails.

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THREE NEW INSECT RECORDS FOR THE AUCKLAND AREA, NEW ZEALAND

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Abstract. Three insect species, *Modicogryllus lepidus* (Walk.) (Orthoptera: Gryllidae), *Gislenia fulva* (Sauss.) (Blattariae: Blattellidae), and *Lampides boeticus* (L.) (Lepidoptera: Lycaenidae), are recorded for the first time in Auckland and in New Zealand.

The three insect species recorded are new to the Auckland area. These are probably new records for New Zealand. One butterfly species, which may be a wind-borne immigrant, appears to be established. The other two species, a cricket and a cockroach, were probably introduced with imported goods. None of them are recorded as interceptions by Manson & Ward (1968).

Order ORTHOPTERA
Family GRYLLIDAE

Modicogryllus lepidus (Walker) (Fig. 1)

The mature male is 17 mm in length, being smaller than the common black field cricket, *Teleogryllus commodus* (Walk.), and larger than the

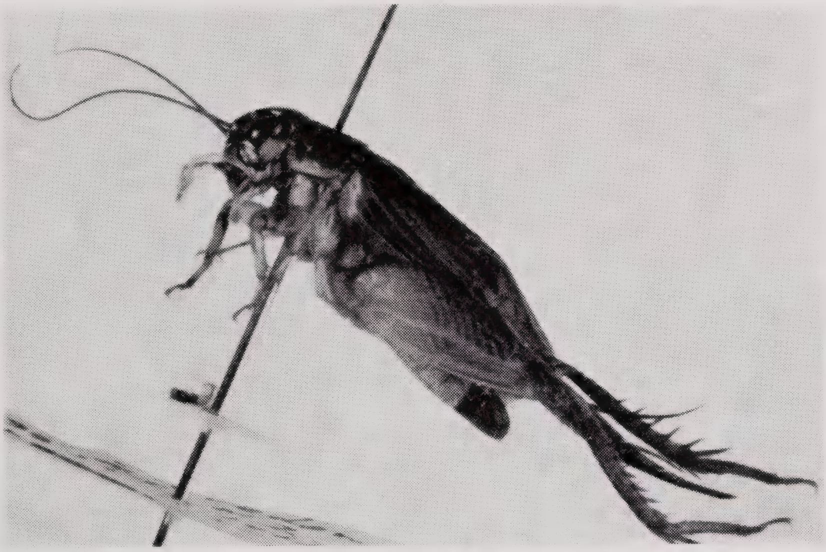

Fig. 1—*Modicogryllus lepidus* (Walk.).

endemic small black crickets, *Lissotrachelus* spp. It is paler than *T. commodus,* being brown to black on the dorsal surface, creamy-white on the ventral surface and basal portions of the legs.

In February 1966, one male, of this species, was captured in a garden at Clevedon, south of Auckland. Mr. H. R. McKenzie, who presented the specimen, reported that it first attracted attention by its song, which is distinct from that of the common black field cricket. A similar song had been heard at the same place some years before, which suggests that a colony may be established in the area. This species is common in Australia, New Caledonia, and Norfolk Island.

Order	BLATTARIAE
Suborder	EPILAMPROIDEA
Family	BLATTELLIDAE

Gislenia fulva (Saussure) (Fig. 2)

The male is a uniform light brown in colour. It is 22mm in length, being smaller than the American cockroach, *Periplaneta americana* L., and larger than the German cockroach, *Blattella germanica* L.

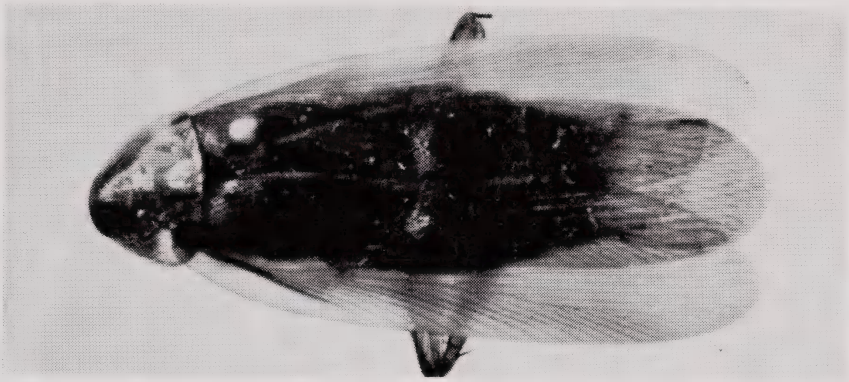

FIG. 2—*Gislenia fulva* (Sauss.).

Two males were taken in South Auckland, in March 1968, one in a house at Otahuhu by Mrs. A. T. Panckhurst, the other at North Papatoetoe Primary School. These occurrences were probably within two or three miles of each other. The species is apparently common in *Eucalyptus* forests in south-western Australia.

FIG. 3—*Lampides boeticus* (L.)

Order	LEPIDOPTERA
Superfamily	PAPILIONOIDEA
Family	LYCAENIDAE

Lampides boeticus (L.) (Fig. 3)

A small blue butterfly with a wing-span of 28-32 mm, being larger than the common blue butterfly, *Zizina otis labradus* (Godt.)*. Wings above are vivid blue-violet. The hindwing has two obvious dark marginal spots, both above and below, and arising between these is a short thin tail.

This is a common Australian butterfly known as the 'pea blue'. A sighting in Auckland was reported to the author during the 1967-68 summer season by Mr. Martin Burnell (of Auckland, previously of Australia) who later, March 1968, collected the species at St. Heliers Bay and Ellerslie. In March also, Master Brian Billing collected and reported specimens in Avondale. During a survey, on 24 March, Burnell and the author found eggs on sweet pea flowers (*Lathyrus* sp. cult.), larvae in the flowers, and adults at Ellerslie. Many adults were seen in Avondale and eggs were found on gorse flowers (*Ulex europaeus* L.) which the adults were visiting. No butterflies were found in the Waitakere Ranges, but they were again collected at Sunnyvale, near Henderson, where eggs were also found on gorse flowers. Thus this butterfly was widespread in the Auckland suburban area at that time. On 30 March, the author collected two adults on gorse flowers at Tauranga Bay, near Whangaroa Harbour, ca. 226 km.

* Recently, Stempffer (1967, *Bull. Brit. Mus. (Nat. Hist.) Ent.* Suppl. 10) has redefined the genera *Zizeeria* Chapman, 1910, and *Zizina* Chapman, 1910, confirming that they are distinct. Consequently, contrary to a previous opinion (Wise, 1965, *N.Z. Ent.* 3 (4) : 19), the present author now accepts the combination *Zizina otis labradus* (Godart).

(ca. 141 miles) farther north. Since then a further report, of specimens collected at Kohimarama, Auckland, between 30 January and 2 February 1968, by Mr. C. R. Craw of Wellington, has been received. Brian Billing has advised that he succeeded in rearing a larva from a gorse flower in Avondale. The pupal stage lasted approximately one week and the adult emerged on 27 May 1968. Recently, Mr. Ian Stringer, of Auckland, has kindly presented a specimen he collected over two years ago. The data label with the specimen reads "Palm Beach, Waiheke Island, Auckland, Legume, 20 Nov. 1965 Ian Stringer".

It seems possible that individuals arrived in New Zealand from Australia, in 1965 or before, and that the species has since established itself in this country. It is hoped that this attractive butterfly will be a permanent addition to our fauna. Auckland is a port and this species may have been accidentally introduced, but it is likely that the butterflies were blown across the Tasman Sea, as many others have been before. The occurrence in the far north of New Zealand supports the latter alternative.

The pea blue butterfly commonly flies a few feet off the ground with a rapid flight which is distinct from the slower, low flight of the common blue butterfly.

ACKNOWLEDGEMENTS. The author is indebted to all the collectors and also Dr. R. S. Bigelow, University of Canterbury, Christchurch, R. G. Ordish, Dominion Museum, Wellington, and C. N. Smithers, Australian Museum, Sydney, Australia, for specimens, information, and advice. Dr. L. Chopard, Muséum National d'Histoire Naturelle, Paris, France, kindly determined the cricket, and P. M. Johns, University of Canterbury, Christchurch, the cockroach. Photographs are by A. W. B. Powell, Auckland.

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IRONA MELANOSTICTA (ISOPODA: CYMOTHOIDAE)

A new record for New Zealand waters, with descriptions of male, female and larval states.

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Auckland Institute and Museum

Abstract. The fish louse *Irona melanosticta* Schiodte & Meinert is recorded for the first time in New Zealand; the male state, female state, and two larval stadia being described from New Zealand specimens. Evidence of the occurrence of protandrous hermaphroditism in the species is discussed.

Specimens of the fish parasite *Irona melanosticta* Sch. & Mein. (Fig. 1) were collected during a population study of the New Zealand garfish *Reporhamphus ihi* Phillipps (Synentognathi: Hemiramphidae) in the Bay of Islands and Hauraki Gulf waters. *Irona melanosticta* has previously been reported from Australia, Japan, Sandwich Islands and South Africa. This is the first record of the genus *Irona* in New Zealand. Powell (1959) listed *Livoneca novaezelandiae* as the parasite of *Hemirhamphus intermedius*

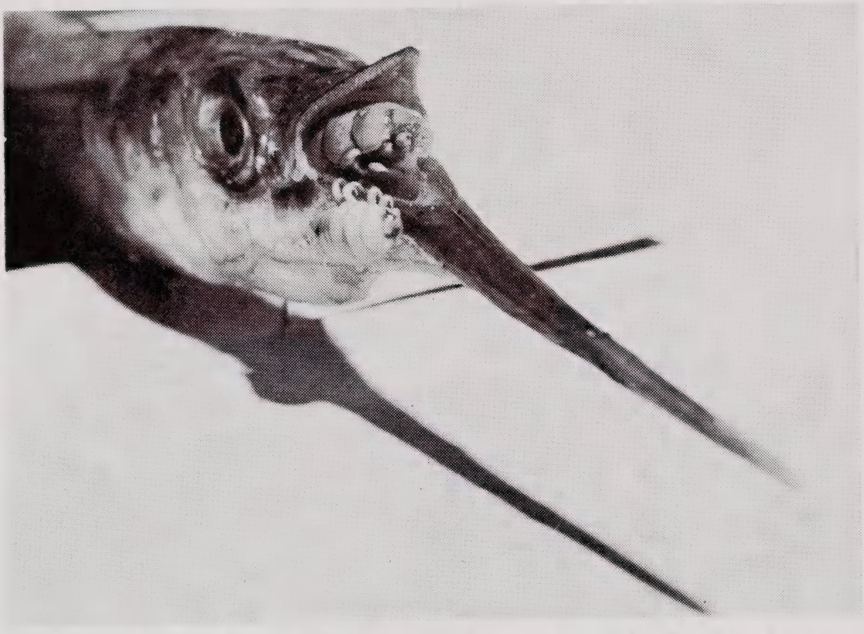


Fig. 1—*Irona melanosticta* on host fish, *Reporhamphus ihi;* female state on buccal pad, male on beak.

Rec. Auck. Inst. Mus. 6 (4-6): 427-434 March 14th 1969.

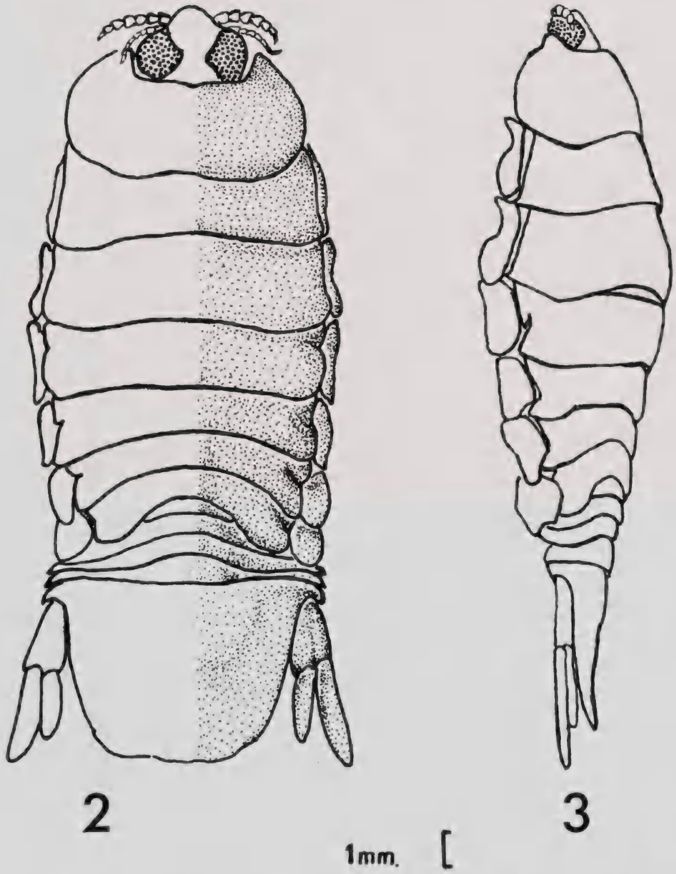
(*Reporhamphus ihi*). However, although this is a closely allied genus, the description of *Livoneca* (Hale, 1940) does not fit any of the specimens collected in this study.

Irona melanosticta Schiodte & Meinert

Irona melanosticta Sch. & Mein. 1884, *Naturh. Tidsskr.* 3, 14: 388, pl. XVII, Figs. 3-5; Thieleman, 1911, *München Abh. Akad. Wiss.* 2, suppl 3: 45, pl. II, Figs. 28, 29; Barnard, 1914, *Ann. S. Afr. Mus.* 10: 373; Hale, 1926, *Trans. Roy. Soc. S.Aust.* 50: 220, Figs. 13, 14.

Female State (Figs. 2-3)

Body form subovate, two and a half times longer than greatest width, which occurs over peraeon segments three and four. Cephalon immersed in first peraeon segment; width and length almost equal, broad at apex. Eyes large, though relatively smaller in large females. First antenna of eight segments, stouter than second; antennules composed of nine segments. Mouthparts: mandible a small obtusely conical molar process and palp of three segments; first and second palp segments subequal, with a pocket-like depression along segment two; first maxilla almost cylindrical, terminated by a single hooked spine and three bristles; second maxilla much flatter,



Figs. 2-3—*Irona melanosticta*. 2. Dorsal view of female. 3. Lateral view of female.

with apex of trunk divided as two lobes, larger lobe bearing four hooks and smaller two hooks at apex; maxilliped also of flat laminar segments, terminated by a single lobe bearing five to seven strongly curved hooks. Peraeon convex transversely; first segment (longest of peraeon segments) sublunate, ventral margin sinuate, antero-lateral angles slightly rounded reaching to level of eyes; second segment slightly shorter than both first and third; third segment subequal in length to first; segments four, five, six and seven successively shorter. Coxal plates continued nearly in same plane as their segments; plates of second segment reaching to postero-lateral angles of their peraeon segments, remaining plates extending distinctly beyond posterior angles of their segments; first two pairs of plates with distinct sinuate lower margins and posterior apices rounded; remaining four pairs of plates with only weakly sinuate lower margins, posterior angles narrowly rounded, often just overlapping plate behind. Pleon immersed in peraeon, first segment often completely concealed; first four segments subequal in length, fifth a little longer. Telson semicircular when perfect, the more anterior portion heavily chitinized. Uropod rami flat, subequal in length; exopod extending just beyond telson. Peraeopods successively increasing in length backwards, seventh peraeopod not longer than fifth or sixth. Pleopods foliaceous and broad, with inner and outer rami approximately equal in area, not extending beyond margin of telson when folded back. Natural colour pale grey, with coxal plates and telson often whitish.

Mean length 22.0 mm (164 specimens).

Male State

Body form subovate, more slender than female, two and three-fourths longer than greatest width. Cephalon relatively same size as in female. Greatest width over peraeon segments two and three. First antenna of eight, second of nine segments. Mouthparts as in female, except a full complement of hooks on second maxilla and maxilliped not found in smaller males. First peraeon segment longest, with antero-lateral angles rounded and not greatly produced; remaining segments successively decreasing in length posteriorly. Coxal plates of second and third segments obtuse posteriorly, larger than remaining pairs which are rounded posteriorly. Telsonic segment a little wider than its medial length. Male appendage of second pleopods reaching to level of apex of inner ramus. Rami of both uropods extending distinctly beyond posterior margin of telson; exopod larger and slightly wider than endopod. Natural colour whitish, turning cream in alcohol.

Mean length 7.5 mm (54 specimens).

Larval State

Mature *Irona* females retain fertilized eggs within a large brood pouch, formed by the growth and overlap of oostegites beneath the peraeon. Of the ensuing larvae found within brood pouches, two stages of development could be recognised: a first stadium developed directly from the ovum and a later second stadium. Within any one brood pouch all larvae are at the same stage of development. While it is possible to arbitrarily separate these two stadia, especially with respect to body size and ornamentation of the appendages, the second stadium is only a continuance of the first stadium and neither larval type differs greatly from the adult form. In both larval stadia the general body form (Fig. 4) is bilaterally symmetrical.

Cephalon relatively large, with apex prominent. Eyes large and conspicuous. Peraeon of six segments, bearing six pairs of peraeopods. Beginnings of seventh peraeon frequently detectable. Pleon of five segments, not immersed in peraeon.

Recognition of first and second stadia is based on the following criteria:

First Stadium. All appendages apparently encased in a protective sheath, beneath which developing form typical of second stadium can be recognised. Mouthparts: palp of mandible of three segments, first two subequal, third slightly smaller and sculptured with short papillate outgrowths; conical molar process present; remaining mouthparts

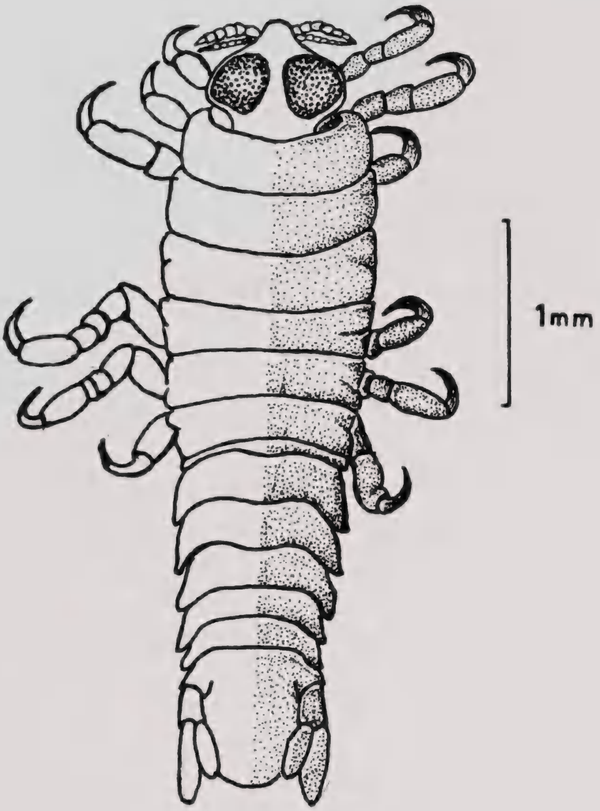


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Fig. 4—*Irona melanosticta*. Dorsal view of larval state.

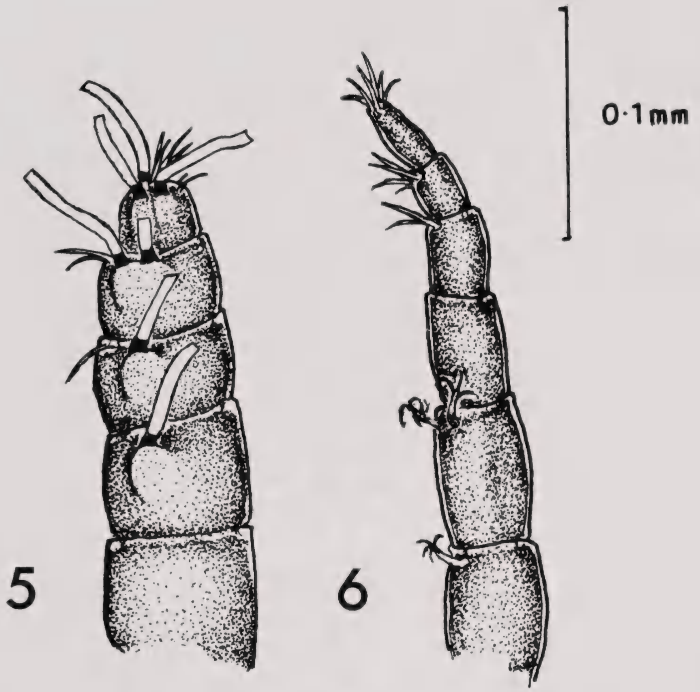
encased in sheath bearing small bumps above developing hooks or spikes. Peraeopods, telson and uropods with scale-like surface sculpture. Slight surface protuberances caused by underlying hair development present along lower edges of most pleopods, telson, and uropods. Terminating claw of peraeopods not strongly curved.

Mean length 2.8 mm (21 specimens).

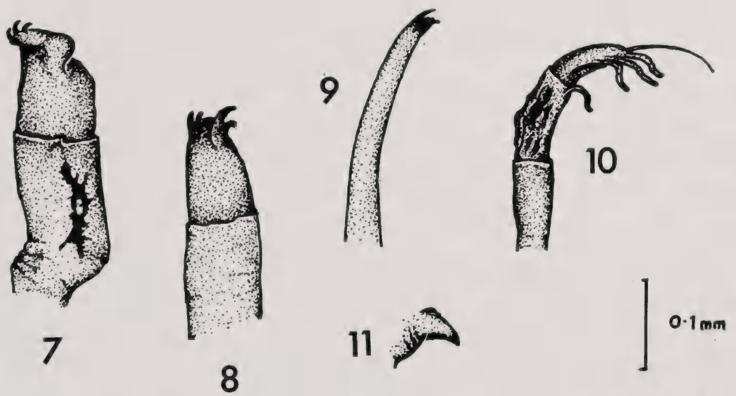
Second Stadium. First antenna of eight segments, with a few single hairs on most segments, but more especially on those nearer apex, and with much longer strap-like outgrowths, three from segment one (terminal cell), two from segment two, one from each of segments three and four (Fig. 5). Second antenna of nine segments (Fig. 6), with a cluster of approximately eight simple hairs at its apex, one or two such hairs on segments two and three below, and short dendritic processes occasionally present on lower segments. Mouthparts (Figs. 7-11) generally resembling adult form; palp of mandible with a longish hair and a series of finger-like projections from its apical cell; second segment with a deeply sculptured surface; apex of second maxilla bearing only four hooks, two from each lobe; terminal lobe of maxilliped with three strongly curved hooks. Anterior peraeopods (Fig. 12) from segments one, two and three with serrated inner edges to claw; peraeopod six (Fig. 13) with three or four rounded spikes on inner border of segment basal to claw; other peraeopods plain. Pleopods (Figs. 14,

15), except endites of third, fourth and fifth, with long plumose hairs along their lower borders; endites of third, fourth and fifth of warty texture, with minute hairs along their inner borders. Telson and uropods (Fig. 16) bordered with natatory hairs; exopod with a single terminating hook at its outer edge.

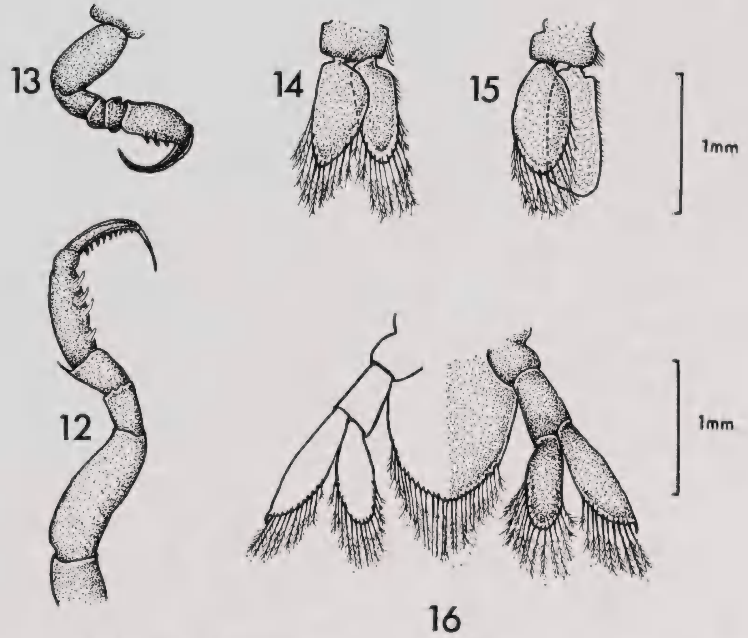
Mean length 3.7 mm (35 specimens).



FIGS. 5-6—*Irona melanosticta.* Secondary larval phase, details of ornamentation. 5. First antenna. 6. Second antenna.



FIGS. 7-11—*Irona melanosticta.* Mouthparts of secondary larval phase (right side). 7. Maxilliped. 8. Second maxilla. 9. First maxilla. 10. Mandibular palp. 11. Molar process.



FIGS. 12-16—*Irona melanosticta*. Appendages of secondary larval phase (right side). 12. First peraeopod. 13. Sixth peraeopod. 14. First pleopod. 15. Fifth pleopod. 16. Telson and uropods.

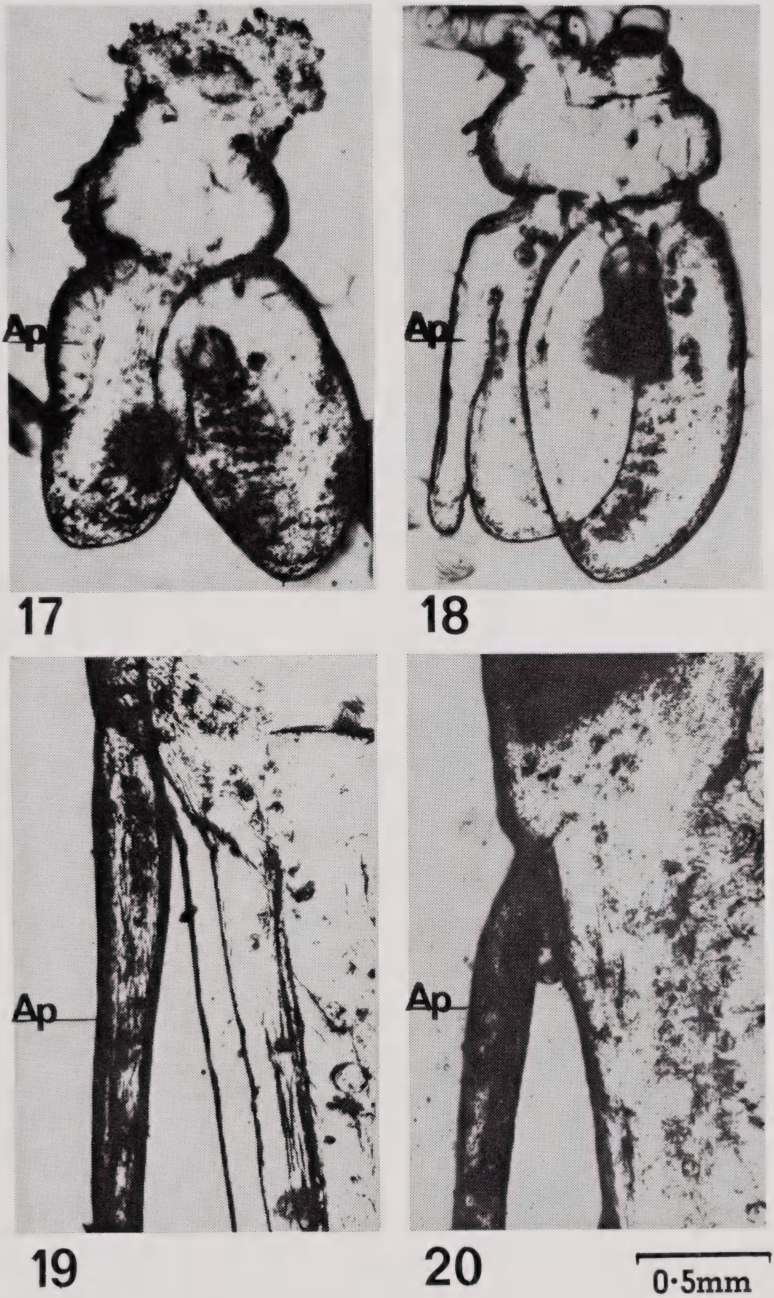
DISCUSSION

Although the three states of *Irona melanosticta* can be recognised as separate entities there is, nevertheless, a degree of morphological similarity which prompted a further study of larva to male and male to female relationships. Hale (1929) has already recorded protandrous hermaphroditism in the family Cymothoidae.

The appendix masculina is functional only in males. Nevertheless, it is found, in various stages of emergence from pleopods, in specimens having the general characteristics of second stadium larvae (Figs. 17, 18), and in various states of degeneration in immature females (Figs. 19, 20). The appendix is considered to be fully developed when it reaches the level of, or extends just beyond, the apex of the inner ramus. Evidence shows that the appendix is long in young males, but does not increase in relative size as they grow.

Males are easily distinguished from the second stadium larvae (Table 1) by the loss of hairs from pleopods, telson and uropods, the degeneration of spines from the respective peraeopods, and the development of the appendix masculina from the endite of the second pleopod.

The change from male to female (Table 2) appears to be morphologically less radical and frequently is only detectable by the degeneration or loss of the appendix masculina. Body shape and colour serve as other guides. It was found, however, that some large males and/or appendix-



FIGS. 17-20—*Irona melanosticta.* Development of appendix masculina. 17. Initial separation of appendix from endite. 18. Appendix almost fully developed.

Degeneration of appendix masculina. 19. Appendix becoming thinner. 20. Appendix tapered at base—the abscission point.

(Ap = appendix masculina.)

bearing females were located in the buccal cavity of the host. It may be inferred that this positional change, from the gill arches to the buccal cavity, is in preparation for their new role as functional females.

These observations, in fact, suggest that protandrous hermaphroditism occurs in *Irona melanosticta*.

ACKNOWLEDGEMENTS. I am grateful to Miss J. E. Robb, University of Auckland, my supervisor, for her assistance and friendly advice. Thanks are also due to Dr. D. E. Hurley, Oceanographic Institute, Wellington, and to Mr. J. Moreland, Dominion Museum, Wellington, for advice; to Mr. G. Batt, University of Auckland, for assistance in photography, and to Mr. and Mrs. G. W. Frater for their kind hospitality at Opunga Cove, Bay of Islands.

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TABLE 1

EVIDENCE OF TRANSFORMATION FROM LARVA TO MALE

Body length (mm)	Appendage hairs	Appendix masculina	Mouthparts
4.0	present	absent	as for 2nd stadium larva
4.1	,,	,,	,,
4.2	,,	,,	outgrowths of antenna and mandibular palp are shorter & thinner
4.5	,,	,,	,,
4.5	absent	just appearing	,,
4.5	,,	half length of endite	,,
4.6	,,	at outer level of endite	,,
4.7	,,	,,	,,
4.9	,,	extends beyond level of apex of endite	i. outgrowths of antenna just persist on terminal segments
5.0	,,	,,	ii. palp of mandible has no outgrowths iii. maxilliped has six terminal hooks (three darkly scleritized, three translucent).

TABLE 2

EVIDENCE OF TRANSFORMATION FROM MALE TO FEMALE

Body length (mm)	
16.0	appendix masculina persists—thin, especially at base
17.8	appendix persists—thin
18.2	appendix persists—very thin, tapered at base which suggests this is an abscission point
18.3	appendix persists—very thin, tapered at base
20.9	appendix persists—very thin, breaking away at base
17.3	no appendix—immature female
19.5	no appendix—immature female
19.8	no appendix—oostegites just apparent
21.2	no appendix—oostegites formed

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